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Development of a Standard for the Health Hazard Assessment of Mechanical Shock and Repeated Impact in Army Vehicles
Phase 2

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New tactical ground vehicles developed by the U.S. Army are lower in weight and capable of higher speeds than their predecessors. This combination produces repetitive mechanical shocks that are transmitted to the soldier primarily through the seating system. Under certain operating conditions, this exposure poses health and safety threats to the crew as well as performance degradation due to fatigue. The Army Surgeon General urgently required the Medical Research and Materiel Command to develop exposure standards for repetitive impacts that are relevant to the environment of soldiers operating modern tactical vehicles.

A five-phase research study was designed to develop a standard for the health hazard assessment of mechanical shock and repeated impact in Army vehicles. Phase 1 reviewed the relevant scientific, medical, and military literature. Phase 2 analyzed and characterized the shock and vibration environment of Army tactical ground vehicles (TGVs). Vibration data from seven military vehicles from the Aberdeen Proving Ground Test Facility were provided by USAARL.

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Seat vibration data were obtained from the following TGVs: M1A1 tank, M1A1 HTT, M1026 HMMWV, B109A3 self-propelled howitzer, M923A2 5-ton cargo truck, XM1076, and an M2HS Bradley fighting vehicle. Data were recorded during on- and off-road operations at various speeds. All data, recorded from seat-pad triaxial accelerometers, were supplied as predigitized acceleration records. The data were frequency weighted (British Standard 6841), and these weighted statistics were evaluated to compare ride severity between vehicles. Components of these data were used to develop acceleration signatures to realistically simulate the motion environment in TGVs.

A conceptual framework was developed which enabled the salient features of TGV seat motion to be quantified and compared. The essential elements of a dose-response model for quantifying health effects resulting from exposure to repeated shocks and vibration were identified, including the potential for biological recovery processes. A procedure was developed involving computer recognition of impulses, including shocks and other transient or nonstationary motions within a background of Gaussian random, or near-sinusoidal, vibration. Using this procedure, seat motion in TGVs was classified into four categories: type 1 - Gaussian random motion; type 2 - periodic deterministic motion; type 3 - intermittent (nonstationary) motion; and type 4 - impulsive motion, including shocks. The ranges of mean RMS frequency-weighted acceleration were determined for type 1 and type 2 seat motions in the x-, y-, and z-axes. Shock waves were classified by initial peak amplitude, fundamental frequency, and decay rate in the x-, y-, and z-axes. A motion signature was created mathematically to realistically simulate the motion environment of TGVs by synthesizing two signals: one to characterize the shocks, and the other to characterize the near-continuous background vibration.

This report, which contains the analytical methods for characterizing the repeated impact environment of Army TGVs through analysis of recorded acceleration signatures, provides a unique method to characterize vehicle motion. The wide range of motion encountered in different Army vehicles traversing varying terrain is described. The theory and logical framework which incorporated signal processing techniques from diverse industry applications was developed mathematically to reconstruct the motion environment. The study developed control signatures to realistically simulate the multi-axis acceleration of TGVs. These signatures were implemented successfully to control the motion platform of a multiaxis ride simulator at Fort Rucker, Alabama. Laboratory experiments in phases 3 and 4 of this study will use this technique to construct motion signatures to assess the effect of triaxial motion on human responses.

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Preface

This document is the second report on the development of a standard for the health hazard assessment of mechanical shock and repeated impact in army vehicles. The objectives of the project are:

- to review, analyze and summarize state-of-the-art knowledge of the health hazards associated with whole-body vibration and repeated impact (Phase 1);
- to characterize the repeated impact environment of tactical ground vehicles (TGVs) through analysis of recorded acceleration signatures, and to develop methods for realistic simulation of the TGV acceleration environment (Phase 2);
- to identify those biomechanical, physiological and pathological human responses that are essential for the prediction of injury risk, and to measure the responses of volunteer subjects under simulated conditions of TGV vibration (Phase 3 and 4); and
- to develop and validate a dose-effect model that will serve to predict the risk of injury to the soldier when exposed to the repeated impact environment of TGVs (Phase 4 and 5).

This report fulfills the requirement of phase two of the project's scope of work, and the second objective. It contains the analytical methods for characterizing the vibration, shock and repeated impacts to which occupants of TGVs may be exposed. This information is used to characterize the seat motion recorded in TGVs, and to develop acceleration signatures for simulation of their motion environment.

The development of the theoretical framework with which to characterize vehicular motion is inevitably mathematical in nature, and is presented succinctly in Part A of the report. The report is structured so that the reader who wishes to avoid the mathematical complexities may omit Part A.

Introduction

Vibration consists of oscillations that are characterized by zero mean displacement, or rotation. There is generally no net translational motion, though the oscillation may be referred to a moving frame of reference (e.g. a moving vehicle). The extent of the oscillation defines the magnitude of the motion, while the (time) rate of oscillation defines its frequency. For convenience and clarity, several types of oscillatory motion are commonly distinguished in the literature, and will be referred to in this report. Examples of the different waveform types are shown in figure 1 (Griffin, 1990). When the character of future oscillations may be determined by past oscillations of a system, the motion is considered to be *deterministic* in nature (e.g. the "sinusoidal" or "multi-sinusoidal" waveforms in figure 1). Deterministic waveforms, or signals as we shall commonly call them when discussing aspects of signal processing, may occur as *periodic* (e.g. sinusoidal) or *non-periodic* motion (e.g. the transient and shock waveforms in figure 1). A second class of signals (considered *non-deterministic*) are those in which future motion of a system is unrelated to its past motion. This important class of signals includes *random* vibration. The properties of random signals must be described statistically. The basic characteristics of such signals are described as: 1) *stationary* (or "ergodic"), that is, with amplitude properties that are statistically time independent (see the "stationary random" signal in figure 1); or 2) *non-stationary*, that is, with time-dependent waveform statistics, as displayed by the "non-stationary random" signal in figure 1.

The classification of physical data as being either deterministic or random may be argued in some cases. The signals shown in figure 1 are representative of the forms of seat motion observed, and serve to provide a framework for discussion of the signal processing methods developed in this report. In practice, combinations of these signals frequently occur. This leads to complexities in establishing the appropriate acceleration magnitudes and frequencies, which are necessary to determine human responses and health effects.

Of primary concern to this study is the specification of human response to vibration containing mechanical shocks, jolts or impacts. The term "shock" is used here to describe a mechanical input to the human body (force, displacement, velocity and/or acceleration) that causes forced disturbances in the relative positions of body parts. Such relative motion of body parts may result in excessive strains within tissues, ligaments

or bones. In this report, the characterization and simulation of shocks and whole-body vibration for the assessment of human health effects are considered.

The quantification of the salient features of seat motion, and their integration into a measure of dose are considered in Part A. An analytical description of the statistics of Gaussian random vibration is provided in which higher-order mean values are introduced. Several methods for characterizing individual and repeated shocks are described, involving both statistical and waveform based measures. The latter measure suggests a model suitable for shock waveform synthesis.

Dose models for exposure to shocks and vibration with arbitrary waveforms are then introduced, after establishing the magnitudes of vibrations at different frequencies that are considered to be equally harmful, by means of frequency weighting functions. The discussion includes the potential for biological recovery processes (time dependant tissue properties such as visio-elasticity or repair mechanisms) to occur both during and after exposure, and uses a formalism suitable for machine computation.

Part A of the report provides the mathematical concepts and tools that are required first to characterize the seat motion in tactical ground vehicles (TGVs), and then to simulate common features of this motion. It also contains several dose concepts that may be validated during the experimental phases of the project. This part of the report is inevitably mathematical in nature and may be omitted at first reading.

The seat motions recorded in a range of TGVs during off- and on-the-road operations are described in Part B, together with values of key measures derived from these exposures. A procedure involving computer recognition of impulses, including shocks, and other transient or non-stationary motions within a background of stationary (Gaussian) random, or near-sinusoidal, vibration is used to classify vehicle seat motion into four categories. A detailed classification of shock waveforms is then employed to analyze the shocks recorded at the seats of TGVs from which representative shocks may be deduced.

In Part C, the synthesis of the shocks and background vibration employed to simulate seat motion and exposures in TGVs is described. These signals are designed for use in Phase 3 of the project: the pilot laboratory experiments. A number of different shock signatures are constructed in which the amplitude, rise time (frequency), number of shocks per minute,

and background level are varied. The signatures are intended to be representative of seat motion observed in the military vehicles. The protocol for these pilot experiments is also described in Part C. These experiments are designed to provide information for planning the main experiments to be conducted during Phase 4 of the project.

Part A: Theoretical representation of human exposure to shock and vibration

I Magnitude characterization

Vehicle motion over uneven terrain results in seat motion (displacement and acceleration) that contains random and deterministic components. Methods of analysis for the assessment of human responses, including health effects, commonly differ for these two components when the latter contain impulses or shocks. In this Section, methods for estimating the acceleration magnitude of shocks with or without background vibration are described. The methods depend on the underlying variation in signal amplitude with time.

Whole-body vibration is a continuous function of time, t, as may be seen from the examples in figure 1. Such a function may readily be represented by its peak, or extreme, values of acceleration: the maximum positive value a_{max} and maximum negative value a_{min}, although these may poorly represent a "typical" value for the motion. As vibration is *defined* as a motion with *zero* mean value, it is necessary to employ a description of signal properties that leads to non-zero measures of "typical" magnitudes of the motion. It is customary in the literature, therefore, to express the average acceleration magnitude of vibration in a time interval T by its *root mean square* (RMS) value, $a_{(RMS)}$.

$$a_{(RMS)} = \left[\frac{1}{T}\int_0^T a^2(t)\,dt\right]^{1/2} \tag{1.1}$$

In this equation, the instantaneous value of the acceleration time history, or waveform, at time t is given by the continuous function $a(t)$.

The "peakedness" in the waveform may then be expressed by the *crest factor*, which is the ratio of the maximum range in amplitude, positive and negative, to the RMS value:

$$\text{CREST} = \frac{|a_{max} - a_{min}|}{2a_{(RMS)}} \tag{1.2}$$

1.1 Statistics of random vibration

There are alternate and, for the purposes of the present work, more appropriate descriptions of the magnitude of random vibration. These depend on amplitude variation of the signal in time, which may be described statistically. Specifically, the magnitude of a random vibration may be described in terms of the properties of its constituent amplitude distribution, as shown in figure 2. In this diagram, the waveform $a(t)$ shown in figure 2A is considered to have been constructed from a sequence of elementary time intervals, at each of which the motion possessed a different acceleration magnitude. The frequency of occurrence of each acceleration magnitude "a" during the sequence forms the acceleration amplitude probability density distribution shown in figure 2C. The expected value of the acceleration-time function (now written for simplicity $a=a(t)$) is defined by its acceleration amplitude probability density distribution, $p(a)$, in terms of the second- and higher-order moments $E(a^2)...E(a^n)$ (Bendat and Piersol, 1986). Thus, for the second-order moment, or "mean squared" acceleration, the expected value is:

$$E(a^2)=\int_{-\infty}^{\infty} a^2\, p(a)\, da \tag{1.3}$$

and for the n^{th}-order moment:

$$E(a^n)=\int_{-\infty}^{\infty} a^n\, p(a)\, da \tag{1.4}$$

For a Gaussian, or "normal", random distribution, inserting the appropriate form for the acceleration amplitude probability density distribution in equation 1.3 leads to (Bendat and Piersol, 1986):

$$E(a^2)=\sigma^2 \tag{1.5}$$

where σ is the standard deviation of the Gaussian random distribution. Thus, in this formalism, the RMS acceleration becomes:

$$a_{(RMS)}=\left[E(a^2)\right]^{1/2}=\sigma \tag{1.6}$$

This expression for the RMS value of the motion, which is applicable to Gaussian random signals, should be compared with the more general definition in equation 1.1.

If the root mean value for the $m^{th}=2n^{th}$ order moment is defined from the corresponding expected value by forming the m^{th} root, as done in equation 1.6 for the RMS value, then, in general:

$$\left[E(a^m)\right]^{1/m}=\left[\int_{-\infty}^{\infty}a^m\,p(a)\,da\right]^{1/m} \tag{1.7}$$

where $m=2,4,6,8,...etc.$

A relationship may now be derived between the m^{th} root mean value and the RMS value (Bendat and Piersol, 1986), which may be shown for stationary signals with a Gaussian random amplitude distribution to be:

$$\frac{\left[E(a^m)\right]^{1/m}}{a_{(RMS)}}=\left[\prod_{k=1}^{n}(2k-1)\right]^{1/2n} \tag{1.8}$$

The relationships between the even-order moments, their corresponding root mean values, and the RMS value are listed in table 1. Note that the SI units of all root mean values are $m \cdot s^{-2}$, and all odd-order moments are identically equal to zero.

It can be seen from table 1 that the root mean value associated with the fourth-order moment (i.e. $m=4$) may be appropriately termed the *root mean quad acceleration* (or RMQ acceleration) where:

$$a_{(RMQ)}=1.32a_{(RMS)} \tag{1.9}$$

for Gaussian random vibration.

The existence of quantitative relationships between higher-order root mean values and the RMS value may be employed as a test of the shape of the amplitude distribution of the signal. In this way, the nature of seat motion may be characterized according to signal content, for example (Gaussian) random vibration. This subject, namely the classification of vibration signals into types, is of considerable importance to the present study, and is discussed in detail in Sections VI and VII.

The probability density function may be accumulated over all possible acceleration amplitudes to form a cumulative acceleration amplitude probability distribution, shown in figure

2B. As the cumulative probability distribution is constructed from a series of acceleration amplitudes measured within elementary time intervals and their frequency of occurrence, it follows that this distribution also determines the fractional time at which the signal is above or below a given acceleration magnitude. A cumulative probability may then also be associated with each mean value. These are listed in table 1 for Gaussian random vibration, and indicate that the RMT value corresponds to a cumulative probability of $P(a)=0.97$. The cumulative probability associated with each root mean value provides another test for the presence of non-periodic or non-stationary signals, and may be used to advantage to establish the presence of shocks within an otherwise random vibration. The theoretical foundation for this test is described in the following subsection.

1.2 Vibration containing shocks

The existence of shocks within a background vibration can be expected to cause the amplitude probability distribution of the composite motion to deviate from the probability distribution of its constituent background vibration, when the shocks exceed some minimum magnitude. The presence of shocks in an otherwise stationary random or periodic deterministic motion can therefore be established from the *shapes* of the acceleration amplitude probability density distribution and the cumulative probability distribution. Such changes in the distribution will be reflected in the relative magnitudes of the expected values, $E(a^n)$. The corresponding root mean values will deviate from the ratios listed in column 3 of table 1 for a Gaussian random motion. The cumulative probability associated with each root mean value (column 4, table 1) will also change to reflect the change in the amplitude distributions. For example a series of shocks superimposed on a background of lower magnitude random vibration will tend to increase the value of higher order moments, root mean values, and cumulative probabilities. This concept is demonstrated in the comparison of values in table 1 with the results of figure 18.

1.2.1 Impulsiveness

An alternative measure of the magnitude of vibration that retains a specific probability value may be obtained by calculating the impulsiveness of a waveform (Brammer and Keith, 1992). This magnitude measure may be defined as:

$$I_{P(a)} = \frac{|a^+ - a^-|}{2a_{(RMS)}} \tag{1.10}$$

where a^+ and a^- are positive and negative amplitudes, respectively, exceeded for a fraction of time specified by the cumulative probability, $P(a)$. As the cumulative probability function $P(a)$ is constructed from a series of acceleration amplitudes, measured within elementary time intervals, and their frequency of occurrence, it follows that this function also determines the fractional time at which the signal is above or below a given acceleration magnitude. Values for these amplitudes may be derived from the amplitude probability density function (figure 2), since:

$$\text{Prob}\left[a^- \le a \le a^+\right] = \int_{a^-}^{a^+} p(a)\,da = P(a^+) - P(a^-) \tag{1.11}$$

In this equation, $P(a^+)$ and $P(a^-)$ define the required probability value for the cumulative probability distribution function, i.e.

$$P(a^+) - P(a^-) = P(a) \tag{1.12}$$

For example when $P(a)=0.97$, then the signal lies between a^- and a^+ for 97% of the total time and exceeds a^- or a^+ for 3% of the total time.

It should be noted that the impulsiveness as defined here, although directly related to the amplitude statistics of a signal, does not depend on the probability distribution possessing a particular *shape*. In consequence, the impulsiveness will provide a measure of the magnitude of amplitude excursions, including shocks, exceeded a specified fraction of the time, irrespective of whether the background vibration consists of Gaussian or non-Gaussian motion. Hence, a comparison between the values of, say, $I_{P(a)}$ when $P(a)$ and $a_{(RMT)}/a_{(RMS)}$ for a vibration of unknown characteristics will provide information on its constituent signals (i.e. its waveform and the shape of the acceleration amplitude probability distribution). Reference to table 1 reveals that these parameters will be equal, and in principle equal 2.16, if the signal is Gaussian random in nature. The magnitude and form of discrepancies in the values of these two parameters may be used in the classification of shock and vibration signals (see Section VI).

It should also be noted that the impulsiveness equals the crest factor when $a^{+}=a_{\max}$ and $a^{-}=a_{\min}$, i.e. when $P(a)=1.0$. The latter measure is, of course, more simply defined in the time domain, without reference to the amplitude statistics of the signal, that is, by equation 1.2.

1.2.2 Higher-order root mean values

The characterization of shock and vibration magnitudes for the assessment of health effects may also be undertaken using parameters defined in the time domain, without reference to the statistical properties of the motion. Thus, a generalized time-averaged, or "root mean", measure may be constructed using the form of equation 1.1, viz:

$$a_{(RM)}=\left[\frac{1}{T}\int_0^T a^m(t)\,dt\right]^{1/m} \qquad (1.13)$$

where *m* is an integer.

Reference to the preceding subsection indicates that non-zero root mean values will be defined when *m* is even. Measures that have frequently been used in the literature to characterize shocks include RMS acceleration, when $m=2$ (i.e. equation 1.1), and RMQ acceleration, which is defined when $m=4$:

$$a_{(RMQ)}=\left[\frac{1}{T}\int_0^T a^4(t)\,dt\right]^{1/4} \qquad (1.14)$$

This definition should be compared with that derived from the amplitude probability density distribution of the signal in Section 1.1. Reference to Section 1.1 and table 1 suggests that the higher the order of the root mean value, that is, the greater the value of *m*, the closer the measure will approach the peak amplitude of the waveform. Values of *m* up to $m=10$ have been employed by Wikström et al. (Wikström et al., 1991), and values up to $m=12$ (a_{RMT}) have been used in the present work. For example, figure 11 shows Gaussian random motion having values of $a_{RMS}=0.66$, $a_{RMQ}=0.87$, $a_{RMT}=1.47$ and $a_{\max}=2.34\,m\cdot s^{-2}$. It should be noted that the measures described by equations 1.13 and 1.14 are equally applicable to all forms of vibration, as well as to shocks. This observation leads to the concept of *generalized dose measures* for assessing human exposure to shocks and/or vibration, and is discussed in Section III.

1.3 Shock waveforms

Waveform-specific measures of shock magnitude may be constructed for selected, idealized shock time histories, such as triangular or trapezoidal shapes. The idealized shock profile may then be expressed in terms of the peak acceleration, velocity, displacement or jerk, and the shock duration, with the rise time and decay rate as implicit variables (see, for example, Griffin, 1990). The present discussion is directed at a description of shock time histories suitable for simulating shocks, for use in the pilot laboratory experiments.

A simple, but generalized, model is therefore employed to describe the shock time history in terms of the maximum acceleration amplitude, frequency, $f\,(=\omega/2\pi)$, and decay rate, δ. It is based on an exponentially decaying sinusoid, which may be represented as:

$$a(t) = \left[a_{max}\sin(\omega t)\right]e^{-(\omega\delta/2\pi)t} \tag{1.15}$$

An arbitrary shock shape may then be constructed from a series consisting of n such terms, each of which possesses its own amplitude, frequency and decay rate, identified by the subscript k.

$$a(t) = \sum_{k=1}^{n}\left[a_k \sin(\omega_k t)\right]e^{-(\omega_k\delta_k/2\pi)t} \tag{1.16}$$

The frequencies of the terms in this series are harmonically related, viz:

$$\omega_k/2\pi = f_1, f_2, f_3, \ldots \quad \textit{for } k = 1,2,3,\ldots \quad \textit{etc.} \tag{1.17}$$

where:

$$f_1, f_2, f_3, \ldots = f_1, 2f_1, 3f_1, \ldots \quad \textit{etc.} \tag{1.18}$$

For use in waveform simulation, a boxcar function must also be introduced, in order to define the shock uniquely in time (see, for example, Otnes and Enochson, 1978). This function has a "top-hat" profile in the time domain, with unity magnitude within the time range from $-T/2$ to $T/2$ and zero magnitude outside this range, viz:

$$U(t) = \left\{ \begin{array}{l} 1 \; for \; -T/2 < t < T/2 \\ 0 \;\; otherwise \end{array} \right\} \tag{1.19}$$

The model for constructing shock time histories then becomes:

$$a(t)=U(t+T/2)\sum_{k=1}^{n}\left[a_k \sin(\omega_k t)\right]e^{-(\omega_k \delta_k/2\pi)t} \tag{1.20}$$

Examples of shock time histories constructed using this model are shown in figure 3. It is evident that damped sinusoidal shock profiles, and profiles with different rise times, may readily be constructed by appropriate selection of the parameters in equation 1.20.

As the purpose of this report is first to characterize, and then simulate, the repeated shock environment of tactical military land vehicles, it is appropriate to consider only those measures of shock magnitude that can subsequently be employed during the laboratory phases of the study. The application of the model to the classification of shock waveforms recorded at the seat-body interface is described in Section VII, and its use for shock simulation in Section VIII.

II Frequency characterization

Human response to vibration is known to depend on the frequency of the motion. The frequency components of a waveform are obtained from its Fourier transform (see, for example, Chatfield, 1989). Thus for a signal in the time domain, such as the acceleration at the seat-body interface $a(t)$, its Fourier transform, $A(\omega)$ may be defined by:

$$A(\omega)=\int_{-\infty}^{\infty} a(t)e^{-i\omega t}dt \tag{2.1}$$

where $i=\sqrt{-1}$. It should be noted that the frequency function $A(\omega)$ contains both real and imaginary parts, which are commonly represented by magnitude and phase, respectively.

A frequency weighting may now be introduced to take into account the variation in human response to different vibration frequencies. The frequency weighting function $H(\omega)$ is designed to adjust the relative magnitudes of various frequency components and so must take the form of the inverse of a frequency contour of equal human responses. The frequency weighting function is thus specified by an equi-noxious contour, which may be defined arbitrarily, theoretically or from subjective, physiological or pathological human responses to vibration. The function is commonly assumed to be independent of the magnitude of the input motion. While this assumption is of limited applicability to biological systems subjected to extreme impacts, its use results from a lack of knowledge of the non-linearity between the input motion and the resultant strains induced within the body. In general, the relationship between human responses to stimuli at different frequencies may involve both magnitude and phase information, and so is represented by a complex function. Application of the frequency weighting function to $A(\omega)$ results in a weighted frequency spectrum:

$$A_W(\omega)=A(\omega)\cdot H(\omega) \tag{2.2}$$

A measure of the magnitude of the hazard posed by vibration containing many frequencies may now be obtained by performing an inverse Fourier transform on the weighted frequency spectrum, viz:

$$a_W(t)=\frac{1}{2\pi}\int_{-\infty}^{\infty} A_W(\omega)e^{i\omega t}\,d\omega \qquad (2.3)$$

The resulting time domain signal, which now represents a measure of the *instantaneous* magnitude of the vibration hazard, is the *frequency weighted* acceleration at time t. The hazard magnitude during the course of exposure to vibration may now be established by applying the methods described in Section I to $a_W(t)$, to construct, for example, the frequency weighted RMS acceleration.

The remainder of this Section is devoted to the specification of functions to represent the hazard posed by oscillatory motion at different frequencies. The potential for representing the response of the body to shocks can be expected to be influenced by the waveform shape. This expectation requires both magnitude and phase information to be retained during analysis, in order to characterize the potential health hazard of deterministic motion. It should be noted that some common frequency weightings described in the following subsections do not provide phase information, and so would not be expected, a priori, to define a consistent measure of the health effects of shocks.

The sequence of mathematical operations described by equations 2.1-2.3 may readily be implemented by computer. Details of the apparatus and procedures used for processing acceleration time histories recorded at the seats of military vehicles, based on these equations, are to be found in Section V.

2.1 Frequency weightings specified by International Standard ISO 2631 (1978) and 2631/1 (1985)

The International Organization for Standardization's (ISO) standard 2631 (1985) provides guidance on the measurement and assessment of vibration in three orthogonal, translational axes X, Y, and Z, for which health exposure limits, applicable to given exposure durations, are specified. The coordinate axes are centered at the heart, but the exposure limits have universally been applied to vibration recorded at the seat-body interface. The vibration limits are specified for 1/3 octave bands. Provision for frequency weighting all frequencies of interest simultaneously, in the manner described in the previous subsection, is specified in terms of the reciprocal of the vibration limits, with a weighting factor of unity in the frequency band possessing greatest transmission. The values of

the frequency weighting functions so formed are shown in figure 4.

It should be noted that the procedure adopted by the ISO for the definition of frequency weighting functions is inherently problematic. Firstly, only values for the magnitude of the frequency weighting may be derived from the vibration limits. The phase information is lost in the process of forming 1/3 octave bands. Secondly, the frequency weighting functions contain points of inflexion (elbows) and arbitrarily terminate at prescribed upper and lower frequencies, neither of which properties can be expected to reflect human responses.

In addition, the standard makes no claim to be applicable to shocks, and specifically excludes vibration with a large crest factor. The largest crest factor to which the standard is considered to apply is somewhat uncertain, both in view of the revision in Amendment 1 (1982) from 3 to 6, and of the lack of a clear definition of crest factor itself.

Nevertheless, the International Standard continues to represent the broadest consensus of the effects of whole-body vibration on man, despite a continuing attempt to improve it for more than ten years. The standard is, however, generally recognized to be in need of revision, with the most likely outcome being close to that adopted by the British Standards Institute, BS 6841 (1987) (Village et al., 1992). It should be noted that some elements of the British standard, such as the frequency weightings, are contained in the draft revision of the International Standard.

2.2 Frequency weightings specified by British Standard BS 6841 (1987)

The British standard (BS) 6841 (1987) "Guide to measurement and evaluation of human exposure to whole-body vibration and repeated shocks" provides a solution to the problems associated with the frequency weightings derived from the International Standard. The British standard is based on the fifth draft of the long-term revision of ISO 2631, and so may be considered to reflect, at least in part, the thinking within the international community at that time (1984).

The primary goal of the British standard is to provide unambiguous guidance on the measurement of human exposures to vibration *and* shocks, and some guidance on the assessment of their relative severities. It attempts to provide reliable

procedures for quantifying the severity of all forms of multi-axis, multi-frequency, random, stationary and non-stationary vibration, and repeated shocks.

To this end, frequency weighting functions are fully defined, in magnitude and phase, both for frequencies at which a health hazard is believed to exist, and outside that frequency range. A unique, frequency weighted acceleration time function will thus result from application of the health-related, and band-limiting, frequency weightings contained in this standard to an arbitrary vibration signal. The frequency weightings applicable to vibration at the seat, W_b (Z axis) and W_d (X and Y axes) are shown, in magnitude only, in figure 5. The corresponding filter equations are detailed in the standard.

2.3 Frequency weightings from biodynamic models

There have been many attempts to predict the response of the human body to whole-body vibration or shocks by means of a biodynamic model (Village et al., 1992). The models tend to be based on analytical convenience rather than physiological or pathological mechanisms. They may be designed to model the response of the total body, or a biological subsystem, such as the spine. In consequence, a model commonly consists of mechanical components, such as masses, springs and dampers, the magnitudes of which are fitted to experimental values of selected human responses to vibration and shocks (von Gierke, 1971).

At the present state of knowledge, the possible complexity of biodynamic models far exceeds the potential for establishing meaningful values for each "mechanical" component. Most models only predict a single output response as a function of frequency (e.g. upper body motion resulting from input to the seat), thus permitting the fitting of few, truly independent parameters. In these circumstances, it is appropriate to introduce only the simplest models, with least components, that offer potential for assessing the health effects resulting from exposure to repeated shocks, and vibration.

The simplest, single-degree-of-freedom, lumped-parameter model consists of a mass, M, connected to a source of motion by a spring with stiffness K and a viscous damper with resistance to motion, C. It can readily be shown that the frequency response function for the base excited mechanical system sketched in figure 6 is (Griffin, 1990):

$$H(\omega)=\frac{K+i\omega C}{K+i\omega C-\omega^2 M} \quad (2.4)$$

It is customary to express this frequency weighting function in terms of the undamped natural (resonance) frequency of the system:

$$\omega_n=[K/M]^{1/2} \quad (2.5)$$

and the damping ratio, which is the fraction of the critical damping, and may be written as:

$$\xi=C/C_n \quad where \quad C_n=M\omega_n \quad (2.6$$

With these substitutions, equation 2.4 becomes:

$$H(\omega)=\frac{1+2i\xi\left(\frac{\omega}{\omega_n}\right)}{1-\left(\frac{\omega}{\omega_n}\right)^2+2i\xi\left(\frac{\omega}{\omega_n}\right)} \quad (2.7)$$

Application of equation 2.7, or 2.4, to the frequency function corresponding to an acceleration time history, by means of equations 2.1 to 2.3, results in a frequency weighted acceleration that now represents the output of the model. As the frequency response function of the model is completely described in both magnitude and phase at all frequencies, a unique, frequency weighted acceleration time function will result.

For the purposes of the present work, values of parameters for the single-degree-of-freedom model have been obtained from two sources, and are listed in table 2. The first model is chosen to be representative of the most precise measurement of human response to small amplitude vibration (Fairley and Griffin, 1989), and the second because of its widespread acceptance for evaluating spinal injury from exposure to large amplitude single shocks in the Z direction (Payne, 1975). The differences between the values of the parameters employed by the two models reflects, in part, the different human responses being modelled, and the magnitude of the mechanical non-linearity of the biological components.

An indication of the agreement between human data and the predictions of the Fairley-Griffin model can be seen from figure 7. In this diagram, the magnitude and phase of the apparent dynamic mass of the seated human body (i.e. dynamic force/acceleration) when subjected to vertical vibration is

compared with the predictions of the model. The human data from 60 persons, 24 males, 24 females and 12 children, ranging in age from 7 to 69 years, have been normalized by the static weight of each individual. It is evident that close agreement between predicted and measured values can be obtained at all frequencies up to 20 Hz, which is approximately four times the frequency of the main body resonance (5 Hz).

The application of the Payne model to the assessment of human exposure to shocks, usually described in terms of the *Dynamic Response Index* (DRI), is discussed in Section IV.

III Integrated dose measures

The purpose of an integrated dose measure is to provide, in a single formula or procedure, a unified treatment of vibration exposures, whatever the nature of the motion experienced by the body - be it continuous, intermittent, random, periodic, transient, single or multiple shocks, and single or multi-axis. While at first sight the specification of such a measure may appear to be an ambitious, perhaps even unachievable, goal, it has, nevertheless, been attempted in some standards (e.g. BS 6841, 1987), and in the derivation of some dose measures (e.g. Griffin, 1982). The advantages of an integrated dose measure are self-evident, although there is no evidence in the literature to determine whether the same measure will apply to different health effects, and/or subjective responses to vibration. The concept is developed here to provide a framework for assessing the exposures recorded in TGVs, and for interpreting the laboratory experiments.

A generalized dose function for exposure to shocks, and/or vibration, for an extended period of time, T, which may encompass a workday, may be formed from a single-number measure of the magnitude of the hazard at time t, for example the frequency weighted acceleration $a_W(t)$, by constructing:

$$D(a_W,T)_{m,r}=\left\{\int_0^T\left[a_W(t)\right]^m dt\right\}^{1/r} \qquad (3.1)$$

In this expression, m and r are constants representing the moment and root of the dose measure respectively.

To establish an estimate of the dose using equation 3.1, it will be necessary to determine an appropriate measure of: (a) the magnitude of the stimulus, using methods described in Section I; (b) the relative hazard presented by vibration at different frequencies, as discussed in Section II; and (c) the combined effect of vibration in different directions. In addition, it will be necessary to specify values for parameters m and r.

Dose measures that may be employed to quantify the health effects from exposure to repeated shocks and vibration are described in the following subsections.

3.1 Dose measures in which moment "m" is equal to root "r"

A series of generalized dose measures may be defined for $m=r=2,4,6,...$ *etc.* The six lowest-order functions are listed in table 3. The origins of these functions may be deduced, for $m=r=2$, by examining equations 1.1, 2.1-2.3 and 3.1. If equation 1.1 had involved the frequency weighted acceleration time history, $a_W(t)$, rather than the acceleration time history, then, clearly:

$$D(a_W,T)_{2,2}=\left\{\int_0^T [a_W(t)]^2\,dt\right\}^{\frac{1}{2}} = T^{\frac{1}{2}}\left[\frac{1}{T}\int_0^T [a_W(t)]^2\,dt\right]^{\frac{1}{2}} \tag{3.2}$$

and:

$$D(a_W,T)_{2,2}=a_{W(RMS)}[T]^{\frac{1}{2}} \tag{3.3}$$

Hence, this dose function may be constructed from the RMS frequency weighted acceleration, and is usually described as the energy-equivalent dose. The adequacy of this dose measure for the assessment of health effects resulting from exposure to shocks has been repeatedly questioned in the literature in that it may underestimate the severity of an exposure containing large amplitude shocks (see, for example, Village et al., 1992). When considering the suitability of alternate dose measures involving higher-order root mean values for the assessment of human exposure to Gaussian random vibration, it should be recognized that *all* dose measures of the type defined by equation 3.1 for which $m=r$ (e.g. as in table 3) will be related. They differ only by a numerical constant and power of time.

For example, the next two dose functions in the series after that in equation 3.3, for which $m=r=4$ and $m=r=6$, may also be written in terms of the RMS acceleration, by virtue of the numerical relationship between a higher-order root mean value and the RMS value for Gaussian random vibration (see equation 1.8 and table 1):

$$D(a_W,T)_{4,4}=1.32a_{W(RMS)}[T]^{\frac{1}{4}} \tag{3.4}$$

and:

$$D(a_W,T)_{6,6}=1.57\,a_{W(RMS)}[T]^{\frac{1}{6}}$$

It is apparent from a comparison of equations 3.3-3.5 that exposures to a given RMS Gaussian random acceleration for different times will result in doses that differ primarily in the power of the exposure duration. The ratio of the two lowest-order dose functions clearly demonstrates this difference in the power of the time function. Thus, from equations 3.3 and 3.4:

$$\frac{D(a_W,T)_{4,4}}{D(a_W,T)_{2,2}}=1.32[T]^{-1/4}$$

An assessment of the accuracy with which such dose functions represent health effects from exposure to Gaussian random vibration may thus be established from exposures to such motion for different times. The numerical constants in equations 3.3-3.6 will, of course, be different for exposures containing non Gaussian shock and vibration. However, equivalent relationships will be derivable for exposures of varying duration to shocks and vibration, in circumstances in which the acceleration amplitude probability density distribution does not change.

For translational motion containing both shocks and vibration, the dose measure with $m=r=4$ has been proposed by Griffin as the preferred measure of human response (Griffin, 1984). In Griffin's terminology, the *vibration dose value*, VDV, is given by:

$$\mathrm{VDV} = D(a_W,T)_{4,4}=a_{W(RMQ)}[T]^{1/4} \qquad (3.7)$$

This, and successively higher-order, dose functions are related to increasingly higher-order root mean values, as is evident from table 3. The latter, in turn, more closely approximate the peak value of a waveform. Hence the higher-order dose functions will progressively give more emphasis to shocks in comparison with random vibration. This property of higher-order dose functions is directly relevant to the objectives of the present study, and so dose functions with moment and order of up to 12 have been employed in the analysis of seat motion data (see Sections VI and VII).

3.2 Dose measures in which moment "m" is not equal to root "r"

Integrated dose functions for exposure to shocks and vibration may, of course, be constructed in which $m \neq r$. Dose functions in which $m>2$ and $r=1$ have been explored by Griffin and Wickström et al. (Griffin, 1982, Wickström et al., 1991). In

general, the properties of these functions are equivalent to those of the preceding section with the same value of m. However, relationships between dose functions with different values of m are significantly affected. For example, the relationship between the two lowest-order dose functions becomes:

$$\frac{D(a_W,T)_{4,1}}{D(a_W,T)_{2,1}}=\frac{a^4_{W(RMQ)}}{a^2_{W(RMS)}} \tag{3.8}$$

For Gaussian random vibration, this equation becomes, by virtue of the numerical relationship between RMQ and RMS:

$$\frac{D(a_W,T)_{4,1}}{D(a_W,T)_{2,1}}=3a^2_{W(RMS)} \tag{3.9}$$

This relationship should be compared with the corresponding relationship for dose functions in which $m=r$, namely equation 3.6. It is evident from the markedly different form of these equations that conclusions concerning comparisons of human responses evaluated using a sequence of dose functions in which $r=1$, as by Wickström et al. (Wickström et al., 1991), cannot be applied to dose functions defined as in Section 3.1. When $r=1$, the ratio of the dose functions is independent of time, whereas in equation 3.6 ($r=m$) the ratio of the dose functions is a time dependent function.

A dose measure for head injury from impacts has been proposed in which $m=2.5$ and $r=1$ (see, for example, Griffin, 1990). This measure, which employs the acceleration time history of the impact without applying any frequency weighting, has been developed into a severity index that has been incorporated into regulations for vehicle equipment and helmets (Versace, 1971).

3.3 Dose measures with recovery processes

The dose measures introduced so far in this Section, while integrating the effects of exposure to oscillatory motions with different magnitudes and waveforms, do not account for the temporal pattern of hazardous events. Thus, such dose measures do not allow for the existence of biological recovery mechanisms that may mitigate the potential health effect some time after an event has occurred, or while exposure to whole-body vibration and/or shock is continuing. The development of dose measures that include recovery mechanisms is of considerable interest to

this study, for inclusion in the dose-effect models to be constructed during the latter phases of the project.

The generalized dose function of equation 3.1 may readily be modified to account for the sequence of individual hazardous events, by segmenting the acceleration time history from which it was constructed into a *time series*. If the u^{th} element of the time series occurs at time t, where $u = 1,2,3,...etc.$, and the elements of the time series are separated in time by δt, then we may write:

$$a_W(t) \Rightarrow a_W(u), \quad a_W(t+\delta t) \Rightarrow a_W(u+1), \; ... \; etc. \tag{3.10}$$

The dose occurring during a time interval ΔT consisting of n elements of the acceleration time series, i.e. $\Delta T = n\delta t$, is then:

$$\delta_k \equiv \delta_k[a_W, \Delta T]_{m,r} = \left\{ \frac{\Delta T}{n} \sum_{u=(k-1)n+1}^{kn} [a_W(u)]^m \right\}^{1/r} \tag{3.11}$$

where $k = 1,2,3,...N$.

In this way, the dose function may be constructed from a series of terms, with dose elements δ_k being computed for successive time intervals, each of duration ΔT. The total dose occurring during exposure to N such dose elements in a time $T(=N\Delta T)$ is then:

$$D_N[a_W, T]_{m,r} = \left\{ \sum_{k=1}^{N} [\delta_k]^r \right\}^{1/r} \tag{3.12}$$

Equations 3.11 and 3.12 should be compared with the original generalized dose function, equation 3.1. Although the equations are conceptually similar, the fundamental difference between them is that each dose element, and the time during the exposure it occurred, is now identified by the value of k. Thus, commencing with the most recent dose element (i.e. $k = N$), the modified dose function may be written:

$$D_N^r[a_W, T]_{m,r} = \delta_N^r + \delta_{N-1}^r + \delta_{N-2}^r + \delta_{N-3}^r + ... \tag{3.13}$$

This expression can be seen to list the dose elements in the *reverse* order in which they were experienced. Hence the health

effect resulting from individual dose elements may now be weighted to allow for recovery processes (see, for example, Chatfield, 1987), viz:

$$D_N^r[a_W,T]_{m,r} = c_0\delta_N^r + c_1\,\delta_{N-1}^r + c_2\,\delta_{N-2}^r + c_3\delta_{N-3}^r + \ldots \qquad (3.14)$$

where the c_j are weights constructed to give less weight to exposure elements that occurred further in the past.

It is beyond the scope of this report to derive appropriate values for these weights, though it is anticipated that a dose function, such as equation 3.14, will be employed in the analysis of the laboratory experiments. An intuitively attractive set of weights for modelling biological recovery processes may be formed by a geometric series, in which each successive weight in equation 3.14 decreases by a constant ratio. An appropriate series for the weights is then:

$$c_j = (1-\alpha)^j \quad where\ \ j = 0,1,2,\ldots \qquad (3.15)$$

and α is a constant such that $0 < \alpha \ll 1$.

Equation 3.14 may then be written by introducing the expression for the weights as:

$$D_N^r[a_W,T]_{m,r} = \delta_N^r + (1-\alpha)\delta_{N-1}^r + (1-\alpha)^2\delta_{N-2}^r + \ldots \qquad (3.16)$$

This form of the dose function leads to a recursion formula suitable for machine computation:

$$D_N^r[a_W,T]_{m,r} = \delta_N^r + (1-\alpha)\left[\delta_{N-1}^r + (1-\alpha)\ \delta_{N-2}^r + \ldots\right] \qquad (3.17)$$

or:

$$D_N^r[a_W,T]_{m,r} = \delta_N^r + (1-\alpha)D_{N-1}^r[a_W,T-\Delta T]_{m,r} \qquad (3.18)$$

IV Dose estimates for exposure to shocks

The development of dose measures for human exposure to shocks appears to have proceeded independently of comparable measures for whole-body vibration. In essence, the former focussed on the time history of the shocks, to quantify specific health or injury issues (e.g. head injury during vehicle crash, or back injury during pilot ejection). The latter tended to focus on responses to different vibration frequencies, to quantify issues such as discomfort.

It should be noted that the application of shock-specific measures to motion consisting of both shocks and whole-body vibration will need the types of stimuli to be separated, and assessments performed separately for exposure to the shocks, and to the vibration. The separation of shocks from other forms of vibration is problematic, requiring a unequivocal definition of a shock. Moreover, the combination of the two exposure components, assessed by different methods, to obtain a total dose has not yet been attempted.

An intuitively more satisfactory approach to the assessment of exposure to shocks and vibration is to derive an appropriate integrated dose measure. This avoids the problems of signal separation, parallel assessments of hazard, and a combination of assessments based on different methods. In this Section measures are introduced that have beed used for the assessment of spinal injury in a seated person. These measures consider single or repeated shocks from motion in the Z direction. An integrated dose model which would utilize such measures is then briefly considered.

4.1 Exposure to single shocks

The potential for injury to the spine from rocket-propelled aircraft ejection seats has been the subject of much investigation, and led to the development of the DRI (Payne, 1975). In the terminology of Section II, the DRI is a single-degree-of-freedom biodynamic model of the human spine with supporting structures. The magnitude of the index, from which the potential for spinal injury is derived, is based on the maximum compression of the spring of the model in response to the shock waveform input to the base (see figure 6). The maximum compression of the spring will correspond to the peak strain on

the spine in the Z direction. This may be expressed in the form of a non-dimensional index by:

$$\text{DRI} = \frac{\omega_n^2 \Delta_{max}}{g} \tag{4.1}$$

where Δ_{max} is the maximum spring compression, and g is the acceleration due to gravity.

An equivalent measure for evaluating exposure to the less intense shocks expected to occur during TGV operation may be constructed using a biodynamic model that better represents the response of the upper body to less intense seat motion. Such models have been derived from the measured dynamic response of the human body (Fairley and Griffin, 1989), or proposed for various body subsystems (see, for example, Allen, 1978b). For the reasons discussed in Section II, the Fairley-Griffin model has been chosen in the present study, to provide an analysis of seat motion based on a biodynamic model (see Section VI).

4.2 Exposure to repeated shocks

The concept of the DRI has been extended by Allen, and others, to the evaluation of repeated shocks experienced by seated persons in the Z direction (Allen, 1977, 1978a, Payne, 1991, Village et al., 1992). For this purpose, a relationship has been proposed between the severity and number of repeated shocks. The severity is expressed by the magnitude of the DRI, and the number of shocks is measured over a 24 hour period. Equi-noxious contours may then be constructed for the risk of spinal injury and discomfort for seated persons, as shown in figure 8 (Allen, 1977).

A procedure for implementing this relationship has been adopted by the Air Standardization Coordinating Committee (ASCC), though the description is open to interpretation (Air Standardization Coordinating Committee, 1982). It requires that shocks be grouped by DRI values into, say, Q ranges with mean DRI value of $(DRI)q$ where $q = 1,2,3 \ldots Q$. Such a subdivision has been performed in figure 9 for the range of DRI values from 2 to 8. If n_q shocks occur in the range $(DRI)q$, then the exposure is considered acceptable by the ASCC if:

$$\sum_{q=1}^{Q}\left[\frac{(DRI)_q}{(DRI_{\max})_{n_q}}\right]\leq 1 \qquad (4.2)$$

In this expression, the denominator is the maximum allowable DRI corresponding to the *observed* number of shocks n_q during a 24 hour period. It is obtained from the selected criterion curve in figure 8, against which the exposure is being assessed.

The form of the discomfort contours in figure 8 may be expressed as:

$$\log(DRI_{\max}) = s\log n_q + b \qquad (4.3a)$$

where b and s represent the intercept and slope of the relationship. As each discomfort contour possesses the same gradient of $s=-\frac{1}{8}$ (Allen, 1977), the equation can be rewritten as:

$$\left[(DRI_{\max})_{n_q}\right]^8 n_q = K_1 \qquad (4.3b)$$

Different values of the constant K_1 will then define the three equi-noxious contours shown in figure 8.

The same equi-noxious contour may also be expressed in terms of the *maximum* number of shocks defined by the contour for exposure to shocks with magnitude in the range defined by $(DRI)_q$, namely N_q. Hence:

$$\left[(DRI_{\max})_{n_q}\right]^8 n_q = K_1 = \left[(DRI)_q\right]^8 N_q \qquad (4.4)$$

or:

$$\frac{n_q}{N_q} = \left[\frac{(DRI)_q}{(DRI_{\max})_{n_q}}\right]^8 \qquad (4.5)$$

Although the ASCC criterion for human tolerance to repeated shock is expressed in terms of the DRI magnitudes (equation 4.2), it should be noted that the Palmgren-Miner cycle-ratio summation hypothesis, on which the ASCC state their procedure to be based, concerns the number of material *cycles*, or in this case *number* of

shocks (see, for example, Shigley and Mitchell, 1983), and not the stress level. The hypothesis, which was developed to account for the fatigue of metals, is commonly expressed as:

$$\sum_{q=1}^{Q}\left[\frac{n_q}{N_q}\right] \leq 1 \qquad (4.6)$$

Implementation of this equation requires counting the number of shocks that fall within prescribed ranges of DRI values. The number is then compared with a predetermined maximum allowable number, for each DRI range. This form of the procedure is preferred for machine computation.

If the Palmgren-Miner cycle-ratio summation hypothesis is employed to define the acceptability of exposures expressed in terms of the DRI, then the term in sqare brackets in equation 4.2 must be raised to the power 8 (as is evident from equation 4.5). The criterion of acceptability thus becomes:

$$\sum_{q=1}^{Q}\left[\frac{(DRI)_q}{(DRI_{max})_{n_q}}\right]^8 \leq 1 \qquad (4.7)$$

No evidence to support this change in the index of the DRI-ratio summation function has been provided by the ASCC. It is unclear whether the ASCC was aware of the inconsistency between the procedure they recommended and the hypothesis on which they state it to be based.

It should also be noted that implementing the compliance criterion by grouping DRI values inevitably replaces the (smooth) functional relation between shock magnitude and number by a staircase, as shown in figure 9. The magnitude of the steps, and hence the deviation from the original relationship, depends on the grouping of DRI values, which in turn will be influenced by the number and magnitude of shocks occurring.

4.3 Dose model with recovery processes

The discussion of Sections III and IV has provided a conceptual framework with which to construct a model for quantifying the health effects resulting from exposure to repeated shocks and vibration. While it would be undesirable to finalize the dose model before the experimental phase of the project, it is appropriate to outline the form of model that

would appear to be required. The following discussion must therefore be considered to be exploratory in nature, and, perhaps, somewhat speculative.

The underlying physical property of oscillatory motion responsible for back injury or pain appears to be related to the compressive, and/or bending, strain induced in the spine. A similar property may well also represent the injury potential of most organs and tissues. It is unlikely that an external measure of internal strain within biological systems will become commonplace, though a method for measuring spinal motion is being explored in the pilot study. In consequence, it would appear at the present time that the strains will have to be estimated from biodynamic models. A one-dimensional dose model could therefore be based on a measure of strain derived from a one-degree-of-freedom biodynamic model. In these circumstances, the strain is related to the net compression of the spring of the model (see figure 6), and may be expressed in terms of the base and mass displacements.

A dose function for exposure to repeated shocks is implied by figure 8, in which the tolerable spinal compression, expressed by the magnitude of the DRI, is related to the maximum daily number of impacts (see equation 4.4). In the formalism of Section 3.3, this dose function may be written for exposure to N_Q shocks of the same magnitude, from equation 3.12, as:

$$D^{r}_{N_Q}\left[a_W,T\right]_{m,r}=\sum_{k=1}^{N_Q}\left[\delta_k\right]^r=N_Q\left[\delta_s\right]^r \tag{4.8}$$

In this equation, the dose element δ_s represents the dose resulting from exposure to one shock, and is, in consequence, obtained by selecting a time interval ΔT that includes only one shock. Equation 4.8 may also be written, from equation 3.11, as:

$$N_q\left[\delta_s\right]^r=N_Q\Delta T\left\{\frac{1}{n}\sum_{u=1}^{n}\left[a_W(u)\right]^m\right\} \tag{4.9}$$

The term in curly brackets expresses, in general form, the higher-order mean value of the time series during this time interval, so that in the nomenclature of Section I (e.g. equation 1.13):

$$a_{W(RM)} = \left\{ \frac{1}{n} \sum_{u=1}^{n} \left[a_W(u) \right]^m \right\}^{1/m} \tag{4.10}$$

Hence the dose function of equation 4.8 may be written when $m=r$ as:

$$D^r_{N_Q}\left[a_W, T\right]_{m,r} = \Delta T \left\{ N_q a^r_{w(RM)} \right\} \tag{4.11}$$

Studies of the fatigue failure of human bone with strain rates reversing approximately once per second suggest that:

$$N_q a^r_{w(RM)} \tag{4.12}$$

if $a^r_{w(RM)}$ represents the strain. The relationship was found to possess a value of r of between 5 and 6 for from 100 to 10,000 cycles fo uniaxial compression (Carter et al., 1981). This number of cycles to failure is consistent with the anticipated range in the total number of shocks occurring during a day. Somewhat higher values or r have been reported for the failure of bone in torsion or rotation, and also of femoral articular cartilage (Sandover, 1986).

There would therefore appear to be grounds for constructing a dose model using an integrated dose function compatible with equation 4.12, and with a form applicable to a time series (e.g. equations 4.8 and 4.9). For this purpose, we note that equation 4.11 can be expressed in terms of the total time of exposure to shocks during the day, $T_Q (= N_Q \Delta T)$:

$$D^r_{N_Q}\left[a_W, T\right]_{m,r} = T_Q \, a^r_{w(RM)} \tag{4.13}$$

For shocks equally spaced in time throughout the day, we can write:

$$T_Q \Rightarrow T \tag{4.14}$$

where T is the total possible exposure time during the workday.

The dose model is then constructed using an expression for the strain of the spine with an appropriate value of r, such as:

$$D\left[a_\Delta, T\right]_{6,6} = \left\{ \frac{T}{nN} \sum_{u=1}^{nN} \left[a_\Delta(u) \right]^6 \right\}^{1/6} \tag{4.15}$$

In this equation, $a_\Delta(u)$ is the time series expressing the spring compression derived from the biodynamic model.

By employing a generalized dose function, the integrated effect of exposure to shocks of unequal magnitude and shocks irregularly spaced throughout the day will be calculated using a plausible relationship between shock magnitude and number. A dose function of this form may be formulated to represent exposure to random vibration, and so offers the potential for constructing an integrated dose model.

Biological recovery processes may be introduced into the model by the method developed in Section 3.3. Hence the one-dimensional dose model suggested by this argument, expressed in a form suitable for machine computation is, from equations 4.15 and 3.18:

$$D_N^6[a_\Delta, T]_{6,6} = \delta_N^6 + (1-\alpha)D_{N-1}^6[a_\Delta, T-\Delta T]_{6,6} \qquad (4.16)$$

where:

$$\delta_N^6 = \frac{\Delta T}{n} \sum_{u=(N-1)n+1}^{Nn} [a_\Delta(u)]^6 \qquad (4.17)$$

Part B: Analysis of vehicle seat shock and vibration data

V Data sources and processing

In order to characterize and simulate the vibration environment experienced by military personnel, it was first necessary to obtain reliable seat motion data for a wide range of vehicles and operating conditions. A primary requirement was that the data not only possess a range of continuous (background) vibration signatures, but that they also contain a sufficient number of impact signatures, in all three axis. Statistics derived from these data could then be used to construct realistic experimental test signals for use on the U.S. Army Aeromedical Laboratory (USAARL) multi-axis ride simulator (MARS).

Data were supplied to British Columbia Research Corporation (BCR) from two main sources. The first source was the Waterways Experimental Station (W.E.S.) laboratory located near Vicksburg, MS. The vibration data obtained from this laboratory were recorded in the Z direction only, and therefore provided an incomplete record of typical operating environments. Because of this limitation, a request was made by BCR for data that contained simultaneous vibration information in the X, Y and Z directions. The staff at USAARL made contact with the US Army Aberdeen Proving Ground in Maryland, and were provided with three-axis acceleration data from a range of TGVs. All data had been recorded by seat-pad accelerometers mounted under the buttocks, that is between the buttocks and the seat, in the X, Y and Z directions specified by ISO 2631 (1985) and BS 6841 (1987). For simplicity, such data will be referred to as *seat motion* data in this report.

The shock and vibration data were analyzed at BCR. Numerous programs were written to implement the analysis routines on the Digital Equipment Corporation VAX 4000-200 computer. A complete listing of these programs can be found in table 4. References to individual programs will be made, as appropriate, throughout the report.

5.1 Sources of data

5.1.1 Data From W.E.S. Laboratories

Vibration data from two different vehicles were provided to BCR from the W.E.S. laboratory. Table 5 summarizes the vehicle types and their operating speed ranges. These vehicles were run over different prepared surfaces (called the Letourneau ride course), which have varying degrees of roughness. The Letourneau course consists of seven parallel ride surfaces that run 500 feet in length and are located a few miles from the W.E.S. laboratories. They are kept groomed with hard gravel and are surveyed regularly, in order to maintain an accurate vertical surface profile for consistent ride quality tests. Table 6 defines the road roughness for each of the seven courses in terms of an average RMS value in inches, which is determined after "de-trending" the course elevation data (for further explanation, see Murphy, 1984). A more detailed description of these courses can be found in the report by Gillespie (1984).

Vertical (Z axis) accelerations were recorded on a TEAC 510 instrumentation tape recorder. Calibration signals were also provided on each tape. The data, in VHS format, were supplied to BCR from USAARL. A TEAC 510 recorder provided to BCR from USAARL (not the same machine on which the data were recorded) was used to playback the acceleration signals. After examination of the calibration signals provided on each tape, the data were replayed to the VAX 4000-200 analog to digital data acquisition system using the GEDAP (General Data Acquisition and Processing) software system (Miles, 1990). Sampling frequency of 2000 Hz was chosen for digitizing the signal, to ensure that impulsive waveforms were accurately represented, see Griffin (1990). Analog anti-aliasing filters with a cut-off frequency of 500 Hz were used (4-pole Butterworth type). A description of the data acquisition system is to be found in Appendix A.

As already noted, the data from W.E.S. contained only vertical acceleration data, which provides a partial picture of the total vibration environment in vehicles. The data were invaluable, however, in that they allowed the data acquisition and analysis systems developed for the VAX 400-200 to be fully exercised and tested.

5.1.2 Data From Aberdeen Proving Grounds Test Facility

Vibration data from seven military vehicles were provided from the Aberdeen Proving Ground Test Facility. Table 7 summarizes the various vehicle types and operating speed ranges. A detailed description of these vehicles can be found in Appendix B, which contains documents supplied by USAARL.

The seven vehicles were run over a number of ride courses located at the Aberdeen Proving Grounds. Each vehicle was run over courses that were judged to be representative of conditions that would be encountered in an operational scenario. The courses are listed in Table 8. It should be noted that not all vehicles were run over every course. From Table 8, it is apparent that the vehicles could be subjected to a comprehensive range of ride conditions. Further details of the Aberdeen courses can be found in a report (U.S. Army Aberdeen Proving Ground, 1981).

Data from the tests performed at the Aberdeen Proving Grounds were supplied to BCR in the form of pre-digitized acceleration records (in units of g's [gravity]) that had been transcribed onto Microsoft DOS format 3.5 inch floppy disks (numbering approximately 60 in all), together with transcripts of the actual tests. The digitizing process was not under the control of BCR, but it is assumed that the data were recorded according to normal procedures (U.S. Army Aberdeen Proving Ground, 1970). Different sample rates varying from approximately 400 to 600 Hz were used. These rates were calculated from the time interval between digitized samples.

Instead of having to playback the acceleration records through the analog-to-digital system, as was done with the W.E.S. data, the digitized data were transferred to the VAX 4000-200 system over the Ethernet connection from a personal computer.

5.2 Digital processing of signals

Digital processing of signals, such as the acceleration waveforms of seat motion, requires the (continuous) time record to be segmented at regular intervals to form a time series as introduced in Section 3.3. The digitizing process results in a somewhat different, but equivalent, form for many of the equations in Part A of the report. Key equations implemented during computer analysis of the data are briefly introduced in this subsection, and all related equations employed in the analysis of data are listed in table 9.

In the terminology of Section 3.3, digital data acquisition occurs at time intervals δt, and the signal is sampled at a frequency of $f_s = \frac{1}{\delta t}$ Hz. Using the nomenclature of Part A of the report, the higher-order mean values of the time series may be written, from equation 4.10, as:

$$a_{W(RM)} = \left\{ \frac{1}{nN} \sum_{u=1}^{nN} \left[a_W(u) \right]^m \right\}^{1/m} \tag{5.1}$$

The root mean square value is defined, as in Section I, when $m=r=2$, i.e.

$$a_{W(RMS)} = \left\{ \frac{1}{nN} \sum_{u=1}^{nN} \left[a_W(u) \right]^2 \right\}^{1/2}$$

Equation 5.2 should be compared with its equivalent formulation for continuous time functions, namely equation 1.1. Higher values of m define higher-order mean values, which, as before, correspond to the root means of the expected values of continuous signals (defined by equation 1.13). For example, the RMQ value of the frequency weighted acceleration time series becomes (as $m=4$):

$$a_{W(RMQ)} = \left\{ \frac{1}{nN} \sum_{u=1}^{nN} \left[a_W(u) \right]^4 \right\}^{1/4} \tag{5.3}$$

The dose resulting from exposure for a time duration of $t = nN\delta t$ to a time series with mean value given by equation 5.1 may be expressed, by analogy with equation 3.1, as:

$$D\left[a_W, T\right]_{m,r} = \left\{ \frac{T}{nN} \sum_{u=1}^{nN} \left[a_W(u) \right]^m \right\}^{1/r} \tag{5.4}$$

For the cases $m=r=2$ and $m=r=4$, this equation yields the RMS and RMQ weighted acceleration vibration doses, which are, for a time series:

$$D\left[a_W, T\right]_{2,2} = \left\{ \frac{T}{nN} \sum_{u=1}^{nN} \left[a_W(u) \right]^2 \right\}^{1/2} \tag{5.5}$$

$$D[a_W, T]_{4,4} = \left\{ \frac{T}{nN} \sum_{u=1}^{nN} [a_W(u)]^4 \right\}^{1/4} \tag{5.6}$$

Equations 5.4-5.6 may be compared with the corresponding equations for continuous functions, equations 3.1, 3.3 and 3.4. The last two equations express the vibration dose in a form suitable for machine computation. As already noted, equation 5.6 is known as the vibration dose value (VDV).

A common statistical measure of an amplitude distribution, which provides some information on the deviation of the shape of a probability density distribution function from that of Gaussian distribution, may be obtained from the kurtosis (Bendat and Piersol, 1986), which is defined as:

$$\text{KURT} = \frac{1}{nNa^4_{W(RMS)}} \sum_{u=1}^{nN} [a_W(u)]^4 \tag{5.7}$$

This function was computed during data analysis, but found little use during interpretation of TGV seat motion, as it was replaced by a closely related measure derived from the higher-order mean values, namely the ratio of the RMQ to the RMS frequency weighted accelerations.

5.3 Data processing and presentation

A block diagram summarizing the measurement and analysis methodology is shown in figure 10. The processing commences after the "digital sampling" block for the Aberdeen data (i.e. the data are pre-digitized), whereas it starts at the data "recorder" block for the W.E.S. data (which are in analog form).

5.3.1 Frequency Weighting of Data

When processing data containing random vibrations in order to assess human comfort or health effects, it is normal practise to first apply a frequency weighting function to the raw data. The frequency weighting function is chosen to emulate the response of the body to the various frequencies contained within the signal. For example, it is known that humans have a much higher tolerance of high frequency accelerations (40 - 80 Hz) than of lower frequency accelerations (4 - 8 Hz) of the same magnitude. Thus, a waveform of 4 Hz which was perceived as a

"shock" by an individual, would not necessarily represent a "shock" if delivered at equal magnitude but at a frequency of 40 Hz. The exact nature of frequency response relationship is disputed and various weighting functions have been suggested for random vibrations and for shocks.

The objective of this phase of the project was to characterise whole body vibration and shocks for the assessment of human health effects. Hence, it was considered appropriate to frequency weight the data to reflect the response characteristics of the human body. This was necessary in order to avoid higher frequencies (e.g. 40 - 80 Hz and > 80 Hz) from dominating the analysis and hence distorting the characterisation of the data in terms of its effects on humans, (perception, transmission tissue damage and health effects). One of the objectives of Phases 3 and 4 of this project is to determine the appropriate frequency weighting functions for repetitive shocks delivered in the x, y and z directions. As these weightings were not available during phase 2, it was decided that the raw data should be frequency weighted using the existing weighting functions. It is assumed that although these may not be accurate in defining the exact weighting function for repetitive shocks, they will be superior to the use of unweighted data in representing the "type" of waveform transmitted to the human.

All data were analyzed with respect to human response using three different methods. The first method employed the frequency weighting in the ISO standard 2631 (1985), the second method employed the British Standard 6841 (1987), and the third used the Fairley-Griffin biodynamic model to frequency weight the Z component of seat motion (Fairley and Griffin, 1989). The frequency weightings associated with ISO 2631 (1974, 1978, 1985) and BS 6841 (1987) are shown in figures 4 and 5, respectively, and the frequency response of the Fairley-Griffin model is indicated in figure 6. A discussion of these frequency weightings is to be found in Section II.

The time series data were frequency weighted by transforming the time series to the frequency domain, using a Fast Fourier Transformation (FFT) routine, and then applying the appropriate weighting factor to each frequency component (see Section II). An inverse FFT then transformed the frequency weighted signal back to the time domain, for output and further processing. The transformations were accomplished using GEDAP program FILTV2 for both the ISO and British standards, and program BIODYN to process input accelerations according to the Fairley-Griffin model. Note that the Fairley-Griffin model is applicable only to

accelerations in the vertical, or Z, direction, while both of the standards include motion in all three directions: X, Y, and Z.

A FORTRAN source code listing for these and other analysis programs written for specialized applications of the GEDAP system is to be found in Appendix C. As already noted, a summary of these programs is given in table 4. The specialized applications implement analysis concepts developed in Part A of the report.

GEDAP Program CREST3 calculates all higher-order statistics, up to the twelfth-order root mean value, for the frequency weighted acceleration time series using equation 5.1. This program also calculates the higher-order dose values (again to order 12) using equation 5.4. The kurtosis, a measure of the deviation of a distribution from that of a Gaussian, is calculated using equation 5.7.

GEDAP Program STAT2 calculates the frequency weighted acceleration amplitude probability density and cumulative density distributions for each data record. This program is a GEDAP proprietary program and, as such, source code cannot be printed. In the output plots, the observed probability density distribution is compared with the corresponding Gaussian distribution, based on the calculated mean value and standard deviation.

GEDAP Program IMPULSE, using input from the probability density distribution (GEDAP program STAT2), calculates the impulsiveness of the signal, as defined in equation 1.10.

In the frequency domain, data were frequency analyzed using GEDAP Program VSD (Variance Spectral Density), after frequency weighting the acceleration signals (using either GEDAP Program FILTV2, or Program BIODYN, as already described). This program is also a GEDAP proprietary program and as such source code cannot be printed, though information is provided by Miles (1990). The spectral density data were then summed to form a 1/3 octave-band RMS acceleration spectrum (using GEDAP Program ISO). Program ISO is an adaptation of a program supplied to BCR by USAARL, and is listed in Appendix C.

Plots were created in Postscript format using the GEDAP GPLOT software package (Miles, 1990). Figure 11 shows a typical analyzed record of the seat motion in TGVs. At the top of the plot is displayed the time series of the frequency weighted acceleration at the seat-body interface. Immediately below the waveform on the left hand side is a graph of the frequency weighted seat motion after it has been transformed to the

frequency domain, where the spectrum is plotted as the RMS acceleration in each 1/3 octave frequency band. The next graph below is the probability density distribution of the frequency weighted acceleration, plotted as a function of instantaneous acceleration magnitude. To the right is a table listing all the statistical and other parameters derived from the frequency weighted acceleration time history of the seat motion. The parameters have been derived or defined, as appropriate, in Part A of this report. The table also lists the location of accelerometers, direction of the seat motion, frequency weighting employed in the analysis, nature of the ground surface and vehicle speed.

The VAX file specification identifies the data file directory, vehicle type, seating location, run number and direction of acceleration. The directory name (in square brackets) specifies the vehicle and the location of the measurement within the vehicle. The root file name indicates the run number while the file-type indicates the direction of acceleration, i.e. the X direction corresponds to .001, the Y direction to .002 and the Z direction to .003.

5.3.2 Batch Processing

Batch files were developed to automate the data analysis and graphing processes. The batch files allow many different GEDAP programs to be run in an orderly sequence while operating on a given data set.

The VMS data directory and file structure used are illustrated by the following example:

```
From the Base Directory:     [VIB.PF_PDF.M1026_HMMWV]
Sub-directory:               [VIB.PF_PDF.M1026_HMMWV.DRIVER]
                             [VIB.PF_PDF.M1026_HMMWV.CURB_FRONT]
                             [VIB.PF_PDF.M1026_HMMWV.CURB_REAR]
                             [VIB.PF_PDF.M1026_HMMWV.ROAD_REAR]
```

Each sub-directory corresponds to the location where the data were recorded. The individual files are of the form: RUN001.001, which identifies the run number and axis direction (as already described) for that particular vehicle and location. Within each of these sub-directories are batch files that control the data analysis and graphing functions. A separate batch command file is used for each vibration direction. Some examples of typical batch processing command files are given in Appendix C.

VI Types of seat motion

The motion recorded at the seats of the TGVs was found to possess a range of magnitudes, frequency content and temporal characteristics. The large number of data records necessitated the development of a method for the discrimination of impulses and shocks from other types of seat motion, by computer. The procedure and its application are described in the following subsections.

The different waveforms that may be expected to occur, and the terminology used to describe them, have been defined in the introduction, and are shown in figure 1 (Griffin, 1990).

6.1 Classification of seat motion by computer

Machine recognition of different waveform characteristics is accomplished primarily by analyzing the acceleration time histories recorded at the seatbody interface, with a separate measure of the frequency content. The basic requirement is to separate impulses from other deterministic (e.g. sinusoidal) or random vibrations.

Stationary random signals were first identified by their statistical properties (see Section I). Reference to column 3 of table 1 shows that the ratios of the magnitudes of the higher-order root mean values to the RMS value will posses known values for a Gaussian random distribution. For example, the ratio of the RMT to the RMS value will be 2.16 (see table 1), for seat motion possessing a Gaussian amplitude distribution. Deviations from the values in table 1 are expected to occur if the acceleration time history does not possess a Gaussian amplitude distribution. Accordingly, seat motion may be considered to be (Gaussian) random in nature if the ratios of its root mean values fall within a limited range of the expected values listed in table 1. The range of expected values for which a waveform will be accepted as random must then be defined in order to characterize the data. For convenience, this test of waveform amplitude statistics is only performed for one higher-order mean value, and is implemented using the ratio of the twelfth-order root mean value (RMT) to the RMS value, i.e.:

$$\frac{\mathrm{RMT}}{\mathrm{RMS}} = \frac{a_{w(RMT)}}{a_{w(RMS)}} \qquad (6.1)$$

The mathematical expression implemented, by computer, for this ratio is given in table 10. The root mean values for a time series are defined in table 9, and equation 5.1.

The higher-order mean value employed for this test of seat motion has been chosen to ensure that the shape of the vibration waveform close to its peak excursions strongly influences the magnitude of the test parameter. Reference to table 1 shows that the RMT acceleration corresponds to the 97th percentile of the amplitude of a Gaussian random motion, where the 100th percentile corresponds to the (once observed) maximum peak-to-peak amplitude of the motion. The latter was not considered an appropriate measure to employ in a study of repeated impacts.

The acceptable range of RMT/RMS about its expected value, in which the acceleration time series is considered to be a Gaussian random vibration, has been established by a detailed examination of approximately 30 analyzed records of the seat motion in TGVs, and set to:

$$2.0 < \frac{\mathrm{RMT}}{\mathrm{RMS}} < 2.5 \qquad (6.2)$$

Values of RMT/RMS are to be found in all analyzed seat motion records, in Appendixes D and E.

An example of seat motion that complies with the requirement of equation 6.2 is shown in figure 11. Reference to the statistics ratios listed in this analyzed seat motion record shows that the computed value of the parameter RMT/RMS is 2.215 for the weighted acceleration waveform plotted at the top of the diagram. As already noted, the expected value of this ratio for a Gaussian random distribution is 2.16. This discrepancy is, however, considered to be insignificant. Close inspection of the acceleration probability density distribution plotted in the lower left-hand part of the diagram reveals that the observed amplitude distribution, shown by the vertical bars, is almost indistinguishable from a theoretical Gaussian distribution. The latter is shown by the dotted line.

It is instructive to examine the characteristics of the signal shown in figure 11 in some detail. The waveform can be seen to contain numerous oscillations with different frequencies and amplitudes (for more detail, see the "stationary random" signal in figure 1). It might appear to the eye that the higher frequency oscillations dominate the waveform, but there is little evidence for this supposition in the 1/3 octave-band frequency

spectrum. While the random nature of the seat motion has already been confirmed, this property does not exclude the existence of large, low-frequency excursions that extend from almost the minimum to maximum acceleration amplitudes (see the oscillations around 12 s from the start of the record). This comparatively large peak-to-peak acceleration would be expected to induce significant internal body strains, perhaps equivalent to an isolated impulse of this magnitude. It is also interesting to note that the crest factor of this seat motion, defined in equation 1.2 and listed as CREST in figure 11, is 3.918. This crest factor would have precluded the seat motion from interpretation by the original version of the international standard, which required the crest factor to be less than 3. This situation arises even though the amplitude distribution of the motion is indistinguishable from that of a Gaussian random distribution! Reference to the summary data sheets in Appendixes D and E reveals that nearly all Gaussian random seat motions observed in TGVs possess crest factors in excess of 3, providing ample evidence to support the need to increase the crest factor limit in the original standard.

It was originally believed that deterministic signals both periodic, such as sinusoidal motion, and non-periodic, such as transient motion and shocks, could be distinguished from each other, and from random motion solely on the basis of their acceleration amplitude probability distributions (for examples of these signal types, see figure 1). An initial attempt was therefore made to establish different signal types using the magnitude of RMT/RMS. Reference to figure 12 shows that the amplitude probability distribution of this nearly sinusoidal motion (see the waveform in the upper part of the seat motion record) differs significantly from a Gaussian probability distribution. As in the preceding diagram, the observed distribution is shown by the vertical bars, and a Gaussian distribution with the same RMS value is shown by the dashed curve. Reference to the statistics ratios reveals that RMT/RMS is 1.344 for this waveform, a value that clearly distinguishes this seat motion from Gaussian random vibration. A similar conclusion may be drawn by examining figure 13. The seat motion in this record possesses a value of RMT/RMS of 1.738 and a waveform that is similarly periodic in nature, but at a somewhat higher frequency (i.e. 4-5 Hz).

At first sight, figures 14 and 15 appear to confirm that non-stationary random and transient deterministic seat motions may be distinguished from Gaussian random and periodic sinusoidal motions, such as those shown in figures 11-13, on the basis of the magnitude of the amplitude probability density parameter,

RMT/RMS. The value of this parameter is 3.244 for the waveform in figure 14, and 2.971 for that in figure 15. It should be noted that the magnitude of RMT/RMS now exceeds the values associated with both Gaussian random and near-sinusoidal periodic motions (i.e. RMT/RMS > 2.5). This observation applies irrespective of whether the intermittent motion is essentially random (figure 14) or tonal (figure 15) in nature.

Inspection of the acceleration amplitude probability density distributions associated with these motions reveals that the distributions in figures 14 and 15 are similar in form, both exceeding their corresponding Gaussian distributions for acceleration amplitudes close to zero. The excess probability of near-zero motion is to be expected for signals that contain quiescent periods. In addition, there is also a small, excess probability of large-amplitude motion, compared with that of a Gaussian distribution possessing equal RMS value (shown, as before, by the dotted line).

It is possible, however, to adjust the amplitude variation, or modulation, of a tonal signal so that its amplitude probability distribution approaches that of a Gaussian random motion. This signal property can be seen, qualitatively, by comparing figures 12 and 15. The former contains a near-constant amplitude sinusoidal signal, while the latter contains a highly modulated, or transient, sinusoidal signal. Reference to the acceleration amplitude probability density distributions shows that the distribution associated with the near-constant amplitude waveform (figure 12) lies below that of the corresponding Gaussian distribution in certain well-defined amplitude regions (i.e. near the maximum excursions, and near zero). In contrast, the distribution associated with the highly modulated, transient sinusoid (figure 15) *exceeds* that of its corresponding Gaussian distribution in exactly these amplitude regions. In consequence, adding these two signal types together in appropriate quantities will generate a signal with an almost Gaussian amplitude probability density function.

An example of an amplitude-modulated, near-sinusoidal seat motion in which these conditions are satisfied is shown in figure 16. It can be seen from this diagram that the seat motion waveform consists of a sinusoidal signal with modulation between that of the waveforms in figures 12 and 15. Inspection of the acceleration amplitude probability density distribution for the waveform in figure 16 reveals that it is close to that of a Gaussian. Furthermore, the test parameter RMT/RMS is now 2.23, and the signal would be incorrectly classified as a Gaussian

random motion. Clearly, an additional test is required for periodic deterministic signals.

The tonal content of periodic deterministic signals may be derived from their frequency spectra. A simple measure of the peak-to-mean ratio of spectral components was therefore developed from the 1/3 octave-band spectrum, which, in turn, was constructed from the Fourier transform of the time series records of seat motion (see Sections II and V). A test parameter, SPECF, was hence constructed from the ratio of the largest acceleration component in the 1/3 octave-band spectrum to the mean 1/3 octave-band spectral level of all frequency bands, viz:

$$\text{SPECF} = \frac{\left[A_{W(RMS)}(\omega_k)\right]_{\max}}{\frac{1}{n}\sum_{k-1}^{n} A_{W(RMS)}(\omega_k)} \tag{6.3}$$

The threshold at which a signal is considered to be dominated by deterministic components, that is, it may be characterized as primarily tonal (sinusoidal) as opposed to Gaussian random seat motion, has, again, been set from a detailed examination of TGV seat motion, to:

$$\text{SPECF} \geq 4 \tag{6.4}$$

Reference to figures 12, 13, 15 and 16 reveals that the values of this test parameter are 9.154, 5.451, 6.304 and 7.721, respectively, demonstrating that these predominantly sinusoidal seat motions are correctly identified by this test parameter, irrespective of the amount of amplitude modulation. In contrast, the values of SPECF for both stationary and non-stationary random seat motion, examples of which are shown in figures 11 and 14, can be seen from these diagrams to be 3.373 and 3.463, respectively. The requirement to distinguish the transient deterministic motion of figure 15 from the periodic deterministic motions of figures 12, 13 and 16 reveals the need for multiple tests of waveform characteristics, since the transient signal is readily identified by its value of RMT/RMS. Hence it would appear that both stationary and non-stationary random, and periodic and transient, signals may be distinguished by combined tests of RMT/RMS and SPECF.

While the discussion of non-stationary and transient seat motion has identified the expected increase in the ratio RMT/RMS above that for a Gaussian distribution, an increase in the magnitude of this parameter is also expected to occur with

shocks, which form a subset of transient signals. It is thus evident that shocks cannot be distinguished from other non-stationary and transient signals on the basis of the magnitude of the ratio RMT/RMS alone, although shocks will be distinguished from Gaussian random and periodic deterministic signals by the value of this parameter. Accordingly, another measure of the acceleration amplitude probability density distribution must be introduced.

The predominant characteristic of an impulse, or shock, is that its peak amplitude is sustained for an extremely small fraction of the time history during which it occurred. A direct measure of the fraction of time the acceleration waveform exceeds a pre-defined magnitude relative to its maximum value, both positive and negative, may be established from the impulsiveness (see Section 1.2.1). This parameter retains a specific probability value, irrespective of characteristics of the waveform. In consequence, the parameter was introduced to separate impulses from other non-stationary random and transient deterministic signals, such as those shown in figures 14 and 15.

In order to compute the impulsiveness, it is first necessary to specify the probability value in the acceleration amplitude cumulative probability distribution at which the parameter is to defined (see, for example, figure 2). Values of the impulsiveness for a range of probability values are listed in the seat motion data analysis records (Appendixes D). Reference to table 1 shows that the impulsiveness defined when $P(a)=0.97$ will be equal to the magnitude of RMT/RMS for a Gaussian random signal. Accordingly, this probability value was chosen for the test of impulsiveness, in order to provide a parameter that, like RMT/RMS, measured a signal property close to its peak amplitude and, as well, to provide a check on the precision of the signal processing algorithms.

Inspection of figure 17, which contains several impacts of differing magnitudes and shapes, and occasional "small bumps", shows that the value of RMT/RMS for this waveform is very large (10.83), while the value of impulsiveness, I(0.97), has become small, and for this signal equals 1.559. The values of the two test parameters have, as expected, clearly diverged for this waveform, thereby providing the potential for identifying the impulsive signal. A similar conclusion may be drawn for the waveform in figure 18. This seat motion involves one shock of greater peak amplitude than those shown in figure 17, several comparatively "smaller" shocks and numerous "small bumps". The combination of these events and the broadband background seat

motion results in a value of RMT/RMS of 8.472, and I(0.97) of 2.088.

The ability of these two parameters to distinguish between impulses and non-stationary random and transient deterministic signals of varying amplitude with values of RMT/RMS greater than 2.5 can be seen by comparing figures 14 and 15, with figures 17 and 18. From these diagrams, it is evident that the intermittent seat motions (figures 14 and 15) possess an impulsiveness of 2.902, and 2.964, respectively. These values are substantially greater than the impulsiveness observed in acceleration time his tories containing short-duration impulses, such as figures 17 and 18. Hence for nonstationary random and transient deterministic signals with acceleration amplitude probability density functions in which RMT/RMS is greater than 2.5, the identification of impulses, which include shocks, and their distinction from intermittent seat motions may be obtained from the magnitude of the impulsiveness. The examination of approximately 30 analyzed records of the seat motion in TGVs led to the threshold at which impulses occur being set to:

$$I(0.97) \equiv I_{(0.97)} \leq 2.6 \qquad (6.5)$$

As has already been noted, the highly-modulated, perhaps transient, sinusoidal seat motion shown in figure 16 possesses an acceleration amplitude probability density function which mimics that of a Gaussian random signal. Inspection of this diagram reveals that this motion is currently classified as a periodic deterministic signal, by its value of SPECF. The highly-modulated, perhaps transient, nature of the waveform in figure 16 is not recognized by the tests for RMT/RMS and SPECF. Just as the waveform shown in figure 16 compromised the performance of the test for distinguishing it from a Gaussian random signal, it also becomes a special case for the test of impulsiveness. By again examining the approximately 30 seat motions, a second condition for testing impulsiveness has been derived to separate transient, near-sinusoidal seat motion, with parameter RMT/RMS in the range 2.0 < RMT/RMS < 2.5, from impulses and shocks. Thus, when the ratio of the higher-order mean values, RMT/RMS, is between 2.0 and 2.5, a signal may possess a value of impulsiveness of:

$$I(0.97) \geq 2.3 \qquad (6.6)$$

rather than 2.6, and still be classified a transient periodic or non-stationary random signal. Application of this condition implicitly requires that the impulsiveness of a Gaussian random

distribution be less than 2.3, a condition that can be seen to be satisfied by the seat motion in figure 11 (for which I(0.97) equals 2.169).

The impulsiveness also provides a further test for seat motion believed to consist of Gaussian random vibration, for which the values of RMT/RMS and I(0.97) should be equal. Reference to figure 11 demonstrates the extent to which this condition is satisfied in practice. It can be seen for this waveform that the values of RMT/RMS and I(0.97) are 2.215 and 2.169, respectively. It should be noted that the seat motion shown in figure 11 is as close to Gaussian random motion as has been observed in TGVs. The difference between the magnitudes of the two parameters reflects the precision with which each can be computed by the signal processing software. While the discrepancy was acceptable for the present work, it reflects the limitations in the performance of the present algorithms.

The complete set of conditions used for machine typing of seat motion in TGVs based on values computed for RMT/RMS, I(0.97) and SPECF are given in table 10. It is evident from this table that the signal tests have been combined to form conditions requiring alternate values of the test parameters. Using these conditions, the seat motions of TGVs have been separated, by computer, into four types:

Type 1 Gaussian random motion (example - figure 11);

Type 2 Periodic deterministic motion, which is typically dominated by tonal (narrow-band) components and may be amplitude modulated (examples - figures 12 and 13);

Type 3 Intermittent motion - non-stationary random and transient deterministic signals (examples - figures 14 and 15); and

Type 4 Impulsive motion including shocks (examples - figures 17 and 18).

It should be noted that the four types of signals, while generally distinct, are not intrinsically separated by boundaries, and so one type of signal will gradually change in character until it becomes dominated by the characteristics of another type of signal. At this point the computer will change the type designation. This comment is particularly relevant to modulated deterministic signals close to the boundary between type 2 and type 3 signals, or type 3 and type 4 signals. An

example of seat motion close to the boundary between type 2 and type 3 signals is shown in figure 16.

The ability to distinguish between signal types depends, in part, on the range of frequencies contained in the motion, and so will be least precise for narrow-band signals, or signals whose frequency content has been reduced by "narrow-band" frequency weighting. This last observation is relevant to the precision of X and Y seat motion typing, as the frequency weighting imposes a limited range of frequencies on the signal (see figures 4 and 5). However, as discussed in Section 5.3, while the unweighted signal may possess different characteristics due to its broader frequency band, these characteristics may not be relevant to the human.

In summary, signals possessing values of the test parameters close to the limits given in table 10 can be expected to show characteristics of more than one type of motion. The computer will select which of the characteristics dominate, according to the rules provided. The limits have been chosen by reference mainly to Z axis seat motion, and are therefore expected to perform better for motion in this direction. Modification of the limits for the X and Y axes may well improve the performance of machine typing for motion in these directions.

6.2 Verification of machine typing of seat motion

The accuracy of machine typing using the parameters and test values listed in table 10 has been explored for 160 records of seat motion in the military vehicles. A subjective visual typing of the motion was made by two observers, who examined each analyzed data record in sequence. The subjective typing was established by agreement between the observers. Although there were 10 records that were considered borderline between signal types, all but one were adjudicated in favour of the typing performed by the computer, which was known to the observers.

One record, shown in figure 19, was considered incorrectly typed for the purposes of this study. The computer identified the seat motion in this diagram as a type 2 signal, that is, a deterministic tonal signal that may be amplitude modulated. While at first sight this conclusion may be considered appropriate, close inspection of the waveform between 13 and 17 s from the commencement of the record reveals the presence of large-amplitude impulses. The dominance of the tonal character of the signal has, in this case, apparently overcome the ability of the machine typing to identify the shocks.

Hence, machine typing of seat motion was observed to be satisfactory in almost all cases and, at worst, resulted in 10/160 errors. An accuracy of at least 90% would thus appear to be achievable by the method described, and was considered acceptable for the purposes of the present study.

6.3 Seat motion observed in tactical ground vehicles

A Detailed analysis of the seat motion recorded in the TGVs listed in tables 5 and 7, presented in the form of the seat motion records in figures 11 to 19, is to be found in appendixes D-1 to D-23, which are bound separately. These appendices con tain analyses for all recorded seat motion after frequency weighting according to: (a) British standard BS 6841 (1987) (see Section 2.2); (b) ISO standard 2631 (1985) (see Section 2.1); and, for motion in the Z direction, (c) the Fairley-Griffin bio dynamic model (see Section 2.3). The analysis employing the bio dynamic model computed the motion of the model mass, i.e. $a_w(t)$ in figure 6, while the other analyses were of the motion at the seat-buttocks interface. For comparison, the unweighted seat motion was also analyzed for one vehicle (M1A1).

6.3.1 Influence of frequency weighting

The influence of different frequency weightings on the anal ysis may be explored by a comparison of seat motion records for each type of signal. The seat motion records of figures 11, 13, 14 and 18 have been selected for this purpose. These diagrams were obtained by frequency weighting the Z direction seat motion according to the provisions of the British standard 6841 (1987). The result of frequency weighting these seat motions according to the international standard, ISO 2631 (1985), and using the Fairley-Griffin biodynamic model are shown in figures 20-23 and 24-27, respectively.

The dominant effect of changing from the frequency weighting of BS 6841 (a) to ISO 2631 (b) and then to Fairley-Griffin (c) is to reduce the high-frequency content of the signal. This change may be seen most clearly by comparing the relatively flat frequency spectrum of the type 1 signal in figure 11, with the spectra in figures 20 and 24. The reduction in the higher-frequency spectral components in figure 24 (frequency weighted according to the Fairley-Griffin biodynamic model) is accompanied by an increase in the spectral components around 4 Hz, as may be

inferred by comparing frequency weightings (a) and (c), shown in figures 5 and 6.

The progressive reduction in high frequency content of the seat motion with change in frequency weighting may be clearly seen in the waveforms. The waveform in figure 11 (frequency weighted according to the British Standard) appears random in nature, with the only identifiable feature being two, large-amplitude, low-frequency oscillations approximately 12 s after the start of the record, as previously noted. Inspection of the waveform in figure 20 (frequency weighted according to the International Standard) shows that these two oscillations are more visible, as are similar oscillations approximately 8 s after the start of the record. The dominant feature of this waveform is now an impulse 1.5 s after the commencement of the record, which is not seen when the seat motion is analyzed using the frequency weighting contained in the British Standard (see figure 11). This low-frequency impulse becomes more dominant when the seat motion is analyzed using the Fairley-Griffin model (see figure 24). It should be noted that the change in frequency weighting also affects the signal typing. Thus, for frequency weightings (a) and (b) the signal is type 1; while for (c) the signal is designated as type 4, that is, dominated by impulses. It should be noted that the waveform in figure 20 is close to the boundary between type 1 and type 4 signals. This observation provides insight into the threshold at which impulses, such as that occurring 1.5 s after the commencement of the record, are detected by the procedure in table 10.

The change in the balance of spectral components between low and high frequencies is also evident for the type 2, 3 and 4 signals (compare figures 13, 21 and 25; 14, 22 and 26; and 18, 23 and 27, respectively). The reduction in the high frequency component of the type 2 signal, as the frequency weighting is changed from (a) to (c), results in this waveform becoming progressively more sinusoidal. This change in waveform is reflected in a large change in the acceleration amplitude probability distribution from figure 13 to 25. The final distribution (figure 25) is closer to that associated with a pure sine wave. Inspection of this waveform shows that the amplitude modulation in this seat motion becomes more evident as the high-frequency component of the signal is reduced (see figure 25).

The primary change in the type 3 signal is the emergence of large-amplitude, low-frequency oscillations as the frequency weighting is changed from (a) to (c), in a manner not unlike that observed with the type 1 signal. These changes are most evident by comparing the waveforms in figures 14 and 26. In parallel

with this waveform change, the signal type also changes to type 4, providing another indication of the boundary between type 3 and type 4 signals.

It is also instructive to examine the modification in the waveform that occurs with change in frequency weighting, from (a) to (c), for the type 4 signal (figures 18, 23 and 27). The bipolar, large-amplitude impulses in the waveform of figure 18 (frequency weighted according to the British Standard), corresponding to both up and down seat motion, become predominantly unipolar impulses when the signal is frequency weighted according to the International Standard (see figure 23). The rapid changes in acceleration are somewhat mitigated when this seat motion is analyzed using the frequency weighting of the Fairley-Griffin biodynamic model (see figure 27). However, the impulsive nature of the waveform remains, with the dominant impulse, which occurs 21 s after the commencement of the record, significantly increased in peak acceleration, from 37.7 to 46.1 $m \cdot s^{-2}$. Inspection of other amplitude measures in figure 27 reveals, perhaps paradoxically, that while the impulsiveness has remained virtually unchanged from that calculated for the waveform in figure 18, most measures of the "peakedness" of the signal have decreased. For example, the crest factor has decreased from 11.43 to 6.66, to reflect the relative increase in magnitude of the more-continuous, lower-frequency oscillations. The latter component of the waveform will ultimately affect the signal type, though the waveform remains clearly dominated by the impulses.

From this discussion of different frequency weightings for the Z direction, there seems to be little reason to choose one in preference to another, and less reason to attempt to summarize seat motion according to each frequency weighting. This observation will also apply to the X and Y directions, for which there is little difference between the frequency weightings contained in the British and International Standards other than the specification of phase in the former. Moreover, the emphasis in this Section is on characterizing the complete motion, rather than on describing solely waveform shapes. It should be noted that all frequency weightings discussed are believed to represent equi-noxious contours for some human responses to vibration. Accordingly, a summary of data analyzed according to one frequency weighting has been performed. The analysis employed the frequency weightings specified by the British standard BS 6841 (1987), as these have already been specified for the revision of the International Standard.

6.3.2 Summary of data

A summary of all seat-motion data, frequency weighted according to the British Standard, is tabulated in Appendix D of this report. The seat motion data recorded during cross-country operations are also summarized separately, in Appendix E.

The ability to reduce the large amount of data to basically impulses (including shocks) and three types of vibration - stationary random, tonal with or without amplitude modulation, and transient periodic or non-stationary random motions - is indicative of the similarities in, and differences between, the seat motion recorded in the TGVs. As the impulses and shocks are a primary interest of this study, this type of motion is examined separately, in Section VII.

Reference to table 11 (M2HS Bradley), which is one of the summary tables in Appendix D, shows that each contains a heading that identifies the vehicle, the location and direction of the seat motion, the frequency weighting employed, and the date of the analysis. A listing of the file identification is given in the first column of the table, to enable the original analyzed seat motion data record to be located in the separately bound volumes (Appendixes D-1 to D-23). The signal type is given in the second column. This has been determined, by computer, using the method described in the preceding subsections. The typing has been performed with the values of the three parameters RMT/RMS, I(0.97) and SPECF computed for each data record, which are listed in columns 3-5. The course over which the seat motion was recorded is given in column 6, and the vehicle speed in column 7.

The various measures of the magnitude of the motion and the consequent vibration doses are listed in the remaining columns of the table. Columns 8 to 10 provide measures of the peak amplitudes of the waveform recorded during the analysis time window, namely that of the acceleration time history shown in the corresponding data record. Only three of the possible six higher-order mean and dose values are listed in the table, because of space limitations. The three mean and dose values chosen for inclusion in the tables, in columns 11-13 and 14-16, respectively, are those believed to be most relevant to the objectives of this study. All higher-order mean and dose values are, of course, reported in the analyzed seat motion data records, as may be seen from an examination of, for example, figures 11 to 18. It should be noted that re-analysis of data from the same record may lead to somewhat different values of the measured parameters, particularly for transient and nonstationary

seat motions, owing to the difficulty of precisely re-aligning the time window.

From the summary of data in table 11, it can be seen that all four types of seat motion occurred during operation of this vehicle over gravel, washboard, paved, soil and cross-country courses. A distillation of these results by seat motion type is contained at the bottom of the table. For the mix of rides shown, approximately one quarter experienced in the Z direction by the commander of this M2HS Bradley were classified as Gaussian random (type 1) motion, approximately one half as near-sinusoidal deterministic (type 2) motion, and one sixth as containing impulses (type 4 motion), some of which will be of sufficient magnitude to constitute shocks (see Section 7).

Mean values and standard deviations have been calculated for all the parameters given in the table. They are included to assist the reader to: a) identify trends between the three vibration components of seat motion; b) compare the seat motions experienced by different occupants of a vehicle experiencing the same ride; and c) gain an impression of variations in seat motion from vehicle to vehicle. It should be noted that forming overall mean values for some of the parameters tabulated has little meaning in terms of the mean magnitude that results. For example, the so-called "mean value" for type 4 signals provides little information regarding the probable amplitude of shocks to expect within the vehicle. An alternative method for describing shocks will be developed in the next Section.

It is appropriate, however, to examine the mean values of stationary random and periodic deterministic signals recorded at the seats of different vehicles (signal types 1 and 2). A summary of the mean values of types 1 and 2 signals are presented in tables 12 and 13, respectively, for the analyses performed using the frequency weightings specified by the British Standard. The results provide a basis for establishing typical values for these types of seat motion in TGVs, for use in the pilot laboratory experiments.

Reference to tables 12 and 13 confirms that the largest amplitude type 1 or type 2 seat motion occurred in the Z direction. For Gaussian random motion, the mean RMS acceleration observed in this direction ranged from 0.11 to 2.53 $m \cdot s^{-2}$. In contrast, the mean RMS acceleration of periodic deterministic motion in the Z direction at the seats of these vehicles ranged from 0.15 to 3.14 $m \cdot s^{-2}$.

The ranges of mean RMS accelerations observed in the X direction for the type 1 and type 2 seat motions of the TGVs were from 0.08 to 0.69 $m \cdot s^{-2}$, and from 0.11 to 2.01 $m \cdot s^{-2}$, respectively. The corresponding ranges of mean RMS accelerations observed in the Y direction for the type 1 and type 2 seat motions were from 0.09 to 0.57 $m \cdot s^{-2}$ and from 0.08 to 0.60 $m \cdot s^{-2}$, respectively.

VII Shocks and repeated impacts

Impulsive motion was observed at the seats of all vehicles. The X, Y and Z directions of seat motion, however, often displayed different waveforms in response to the same input to the vehicle. A typical variation in the components of seat motion during cross- country operation can be seen from figures 28, 29 and 18, where the difference in scale of the ordinate of the waveform should be noted. These seat motion records for the X, Y and Z direction, respectively, resulted when the M1A1 was driven at 20 m.p.h. over rough loam.

Inspection of the time histories of the motion in these records shows that the extremely large impulse in the Z direction (figure 18) 21 s after the commencement of the record is mimicked in the X direction (figure 28). In the latter record, a similar shaped impulse of approximately one-third the magnitude of that in the Z direction is observed. However, the seat motion at this time in the Y direction is of much smaller amplitude and very different character (figure 29). Indeed, while there are clear similarities in the seat-motion waveforms for the X and Z directions, it is difficult to reconcile these features with those dominating the Y component of the motion. Thus it would appear that this input to the vehicle resulted in the driver experiencing large up-and-down and fore-and-aft motions. A combination of these motions may be suspected to play a significant role in the development of back injuries.

The extent to which the frequency weighting has influenced the shape and magnitude of the impulse waveform can be seen, for the Z direction, from figure 30. This record has been analyzed without any frequency weighting for the same seat motion of the M1A1's driver. It can be seen by comparison with figure 18, which is the same motion after frequency weighting according to the British standard 6841 (1987), that the main effect of this frequency weighting is to reduce the peak amplitudes by approximately one third, and to introduce a bipolar nature to the initially unipolar impulses. While the change in magnitude of the impulse is due to the magnitude (or modulus) of the frequency weighting, shown in figure 5, the change in shape is due primarily to changes introduced in the relative phase between spectral components, at different frequencies. This deduction may be confirmed by comparing the unweighted waveform for this vehicle impact (figure 30) with that observed after frequency weighting using the International Standard (figure 23). The latter has been constructed assuming that there are no phase

shifts introduced by this frequency weighting. It should be noted that the signal processing methods employed in the present study permitted such a frequency weighting to be created in software. A phase-shift free, analog filter would, however, be virtually impossible to construct physically.

A detailed analysis of seat motion records containing impulses was thus undertaken without frequency weighting and is described below in sections 7.1 to 7.3.

7.1 Shock definition

It is evident from the discussion of Section VI that machine typing can generally identify seat motions containing impulses. The focus of the analysis presented in that Section was on measures with which to characterize the complete motion. In contrast, the focus in this Section is on measures with which to characterize individual shocks.

The classification of an impulse as a shock requires that there be at least a working definition of the latter. The definition adopted for the present study is summarized in figure 31. To be considered a shock as opposed to another form of non-periodic, deterministic signal, the motion must be more than 1.0 g's in peak amplitude, possess a fundamental frequency between 0.6 and 60 Hz, and be separated in time from an adjacent event by at least 0.25 s.

Several types of shock waveforms have been defined. The descriptions are based on the shape of the waveform. As one purpose of shock characterization is to identify waveforms for use in shock simulations, the definition employs waveforms that may be generated by equation 1.20. For simplicity in shock simulation, this equation is implemented using the lowest frequency (fundamental) term, which results in waveforms that are damped sinusoids. The type of shock is then defined by the polarity of the initial motion, and the number of oscillations in the direction of the initial motion.

Schematic representations of types +1, +2, -1, and -2 shocks are shown in figure 31. Higher-order shocks (types +3, -3, etc.) are defined in an identical manner.

7.2 Shocks observed in tactical ground vehicles

The impulses detected in the seat motion of TGVs have been analyzed in two ways. Firstly, shocks were selected during vehicle usage over all available ground surfaces and, secondly, shocks occurring during cross-country operations were selected from the records of all vehicles. Details of all shocks analyzed are to be found in Appendix F.

The process of analysis was the same for all records of seat motion, and is exemplified by figures 32-34, and table 14. The last mentioned is one of the shock waveform analysis tables in Appendix F. The first four columns of this table identify the vehicle (M2HS), the location of the seat-pad accelerometers (Commander's seat), the record (number 23), and the direction of seat motion (Z).

Reference to table 11 shows that there were four records during which the commander of this M2HS Bradley experienced type 4 motion in the Z direction - records 22, 23, 40 and 44. Of these, records 23 and 44 were selected for the general analysis, and record 23 for the cross-country analysis. By coincidence, both of these seat motions were recorded during cross-country operation of the vehicle.

A frequency unweighted waveform of the complete record selected was first obtained. The unweighted acceleration waveform for record 23 is shown in figure 32. This waveform can be seen to consist of both large- and small-amplitude impulses, within a background of continuous vibration. The identification of shocks within this record of seat motion requires application of the definition contained in figure 31.

Inspection of figure 32 reveals that establishing the number of shocks occurring during seat motion is not clear cut, owing to the amplitude fluctuations in the waveform. The number of shocks in this and all other shock waveform records was established subjectively by observation, and required the agreement of two observers. It this way, it was judged that 9 shocks occurred during the time history shown in figure 32. This information has been recorded in column 6 of table 14. The maximum and minimum times between these shocks may similarly be estimated by observation, and is recorded in column 7 and 8 of the table. Of these shocks, the five most easily recognizable were selected for detailed examination. These events occurred approximately 2.5, 6, 10, 13 and 17 s from the commencement of the record. Shock parameters for each of these events are listed in separate rows of table 14 (see rows 1-5).

The analysis then proceeded by examining a detailed record of each event. The fourth and fifth events in figure 32 are plotted using an expanded time scale in figures 33 and 34, respectively, for this purpose. With the additional time resolution, the two events can be seen to consist essentially of a short-duration unipolar impulse followed by a lower-frequency decaying sinusoid, all immersed in a tonal background with a frequency in excess of 50 Hz. By comparing the waveform detail in figure 33 with the total waveform in figure 32, this shock complex was designated a +3 type shock, with a peak positive (upward) acceleration estimated to be +2.0 g's, and a peak negative acceleration estimated to be -1.3 g's. The mean frequency during this event is 1.6 Hz. This information is recorded in columns 9-12 of table 14 (row 4).

A similar examination may be made of the fifth event in this seat motion, by comparing the waveform detail (figure 34) with the overall waveform (figure 32). From these diagrams, it is evident that the fifth event consists of a type +1 shock, with peak positive acceleration estimated to be 3.2 g's, peak negative acceleration estimated to be -1.0 g's, and a mean frequency of 1.8 Hz.

In this way, a listing of the shock types and parameters of easily recognizable events that occurred during a single seat motion data record is obtained. This process is then repeated: a) for different data records; b) for different seats in the same vehicle; and c) for different TGVs. Appendix F contains details of 49 shocks observed during operation over all ground surfaces, and over 50 shocks observed during cross-country operations. Since the latter are a subset of the former, a cross-country seat motion record may appear in both listings.

A summary of the important parameters of shock data from Appendix F is contained in tables 15-20. The compilation of shocks during vehicle usage over all surfaces is given for each direction of motion in tables 15-17, and during cross-country operations in tables 18-20. From an examination of these tables, it can be seen that most shocks occurred in the Z direction. The comparatively few shocks in the X direction during cross-country operation is a consequence of the shock definition employed, which excluded impulses with magnitudes of less than 1.0 g's.

Reference to these tables shows that the most commonly observed shock in the Z direction during cross-country operation of TGVs was a type +2 shock (table 20). The maximum (peak) positive acceleration observed in this type of shock was 6.5 g's, and the maximum (peak) negative acceleration was -2.0 g's. The

fundamental frequency of the shock waveform was in the range of from 0.95 to 6.0 Hz, and there were a minimum of three such shocks a minute, and a maximum of eight per minute. This analysis is based on an examination of 30 shock waveforms.

The most commonly observed shock in the X direction during cross-country operation of TGVs can be seen from table 18 to have been a type +1 shock, with a maximum (peak) positive acceleration of 3.7 g's, and maximum (peak) negative acceleration of -3.0 g's. The fundamental frequency of the shock waveform ranged from 1.0 to 60 Hz, and there were a minimum of 20 such shocks a minute, and a maximum of 60 per minute. The analysis is based on an examination of 10 shock waveforms.

Similarly, the most commonly observed shock in the Y direction during cross-country operation of TGVs can be seen from table 19 to have been a type +1 shock, with a maximum (peak) positive acceleration of 2.7 g's, and maximum (peak) negative acceleration of -1.4 g's. The fundamental frequency of the shock waveform ranged from 0.8 to 40 Hz, and there were a minimum of 11 such shocks a minute, and a maximum of 29 per minute. This analysis is based on an examination of 18 shock waveforms.

Corresponding summaries of the most commonly observed shocks when the TGVs were operated over all available ground surfaces may be derived from tables 15-17.

7.3 Repetitive shocks and impacts

The definition of shock requires each event to be separated in time by at least 0.25 s. Repeated shocks, or impacts, may hence occur at a rate of up to four a second. An example of repeated impacts recorded at the driver's seat of the M109A3 is shown in figure 35, where it can be seen that few of the peak accelerations exceeded 1.0 g's. Such repeated impacts are included in the shock analysis when each impact is of sufficient magnitude. It should be noted that repeated impacts of the type shown in figure 35 were infrequently observed during cross-country operation of TGVs.

Reference to the seat motion in figure 19 shows that repeated large-amplitude oscillations, which may well be subjectively assessed as repeated impacts, have also been observed. These apparently deterministic motions were not included in the shock analysis when identified as type 2 seat motions, and tend to occur when vehicles operate on washboard, or

other regularly-profiled prepared surfaces. Such motions may be simulated by frequency-band limited square waves.

Shocks similar to those between 13 and 17 s from the commencement of the record in figure 19 have, of course, been included in the shock analysis when the ratio RMT/RMS for the motion exceeds 2.5. The value of this parameter in the seat motion of figure 19 was 2.334.

PART C: Vibration and shock simulation

VIII Signal generation

8.1 Shock and vibration simulation

It would appear from the field data reported in Part B that the shock and vibration environment in TGVs may be considered to consist of a background vibration interspersed with various types of shock waveforms. Examples of seat motion exhibiting this combination of signals are to be found in figures 17, 18, 30, and 32-35. These waveforms were all observed during cross-country operations, there being fewer shocks recorded when the vehicles were operated on roads.

Appropriate values of the shock parameters for use in shock simulation may be established by reference to tables 18-20. An appropriate range of RMS accelerations for the background vibration may be deduced from table 12 or 13. Hence, simulation of the shock and vibration environment at the seats of these vehicles may be achieved by a synthesis of two signals: one to characterize the shocks, and the other to characterize the near-continuous background vibration.

For the purposes of the present study, shocks were simulated using the lowest frequency (fundamental) term in equation 1.20, resulting in a damped sinusoidal waveform. The simulation requires the waveform to be in the form of a time series (i.e discrete time increments), in order that a digitized signal may be constructed. Thus, recasting equation 1.20 into a time series with 100 time increments, or samples, per second leads to the following expression for the lowest order (fundamental) term:

$$a(u) = U(t + T/2)\left[a_1 \sin\left(\frac{\omega_1 u}{100}\right)\right] e^{-(\omega_1 \delta_1 / 200\pi)u} \qquad (8.1)$$

This form of the equation has been used to generate shock signals for the pilot laboratory studies.

The basic characteristics of this time series have been chosen to be representative of the shocks most commonly recorded in the Z direction during cross-country operation of the TGVs, namely a type +2 shock with decay rate $\delta_1 = 2.5$. Examples of waveforms with these properties are shown in figure 3(A) and (C).

It was anticipated that the laboratory experiments would require shocks possessing different frequencies and peak amplitudes, which may readily be constructed by changing the appropriate parameters in equation 8.1 (i.e. ω_1 and a_1).

The background vibration was simulated by Gaussian random vibration. Reference to Appendix E reveals that there are few type 1 or type 2 motions observed during cross-country operation of TGVs. Thus, without clear evidence for the dominance of one or other type of seat motion, the more suitable background signal for the laboratory experiments was chosen. This signal was produced by computer, using a Gaussian pseudo-random number generator. A time series so generated is shown in figure 36.

It can be seen from the acceleration waveform of figure 36 that the waveform is not unlike that in figure 11, which is characteristic of a type 1 Gaussian random seat motion. Further evidence for the Gaussian random nature of the time series used to construct the waveform may be obtained from its amplitude probability density distribution, shown in the lower left of the diagram. Although the general similarity to the expected shape of the distribution function can be seen, the best evidence for the Gaussian random nature of the signal is obtained from the values of RMT/RMS and I(0.97), which are 2.09 and 2.14, respectively. From the discussion of Section VI, the values of these parameters are both expected to be equal to 2.16, for a Gaussian random signal. This condition is adequately satisfied for this simulated signal, which also meets the requirements for a type 1 seat motion (see Section VI).

8.2 Multi-axis ride simulation facility

Shock and vibration environments are generated for the laboratory experiments by the USAARL multi-axis ride simulator (MARS), through computer control of a hydraulically-activated three-axis vibration exciter. Each of the three orthogonal axes is activated by a separate hydraulic ram, which is controlled by an electronically-activated spool valve. The control signals sent to the spool valve are processed by an iterative procedure, which is capable of achieving a high degree of accuracy between the resultant acceleration waveform and the desired waveform.

The limits of motion generated by the system are governed by a number of different factors. The software controlling the vibration exciter ensures that the system does not exceed preset displacement, velocity and acceleration limits. Of primary

importance is that the system does not operate in a manner that would harm a subject. A nomograph delineating the limits established for subject protection in the 2 to 40 Hz frequency range is shown in Figure 37. This nomograph is applicable to all three axes of motion.

A nominal 4 g's maximum acceleration limit has been established to prevent subject injury. A limit of ±2.5 inches displacement is due to shock absorbers, while physical stops are at ±3.5 inches.

Control of motion in each axis is performed by a digitized time series, corresponding to the target, or desired, acceleration waveform. The characteristics of the digital control sequence must follow the stringent requirements of the software, which is currently running on a Digital Equipment Corporation PDP-11 mini-computer. The system software requires that the target acceleration time series be digitized at a rate of 100 samples per second using a bipolar 13-bit data conversion, with an input range of 10.0 volts (i.e. + 10.0 V is represented by the digital values + 8192). The system calibration is set so that 1.0 V corresponds to 1.0 g's acceleration. Control signals are generated in blocks of 256 data points, corresponding to 2.56 seconds of acceleration.

Further details on the MARS system can be found in the report by Jenkins (1991).

8.3 Implementation of waveforms on the MARS facility

Currently, control records of up to 330 seconds have been generated and reproduced on the MARS system. The digital control sequence for each axis is prepared using a number of programs developed on the GEDAP software system, and is described in the following subsections.

8.3.1 Gaussian waveform generation

In order to synthesize the background vibration, a Gaussian random number generator was used to produce the appropriate distribution of acceleration amplitudes, as described in Section 8.1. For convenience, this time series was constructed using software running on an IBM PC, with the resulting file transferred to the VAX 4000-200 over an Internet connection.

A Gaussian random number time series was synthesized with a 1.0 $m \cdot s^{-2}$ RMS amplitude (frequency unweighted), and with a 82.0 s duration. This basic building block is located in the VAX directory [vib.sig_gen] and has the file name gaus82.002. Gaussian waveforms of any duration may now be constructed using the GEDAP programs EXTRACT (proprietary program) and APPEND. Although this particular waveform has zero mean and is band-limited to frequencies from 0 to 80 Hz, it is further band limited to frequencies between 2 and 40 Hz, to satisfy the performance requirements of the MARS vibration exciter. This is done using GEDAP program FILTA (proprietary program). The file can also have its level changed using the GEDAP programs TRANSFORM1 (proprietary program) and MULTIXY (see Appendix C).

8.3.2 Shock waveform generation

GEDAP program SHOCK (Appendix C) is used to generate shock waveforms. This program generates type +2 shocks, which may be defined by their constituent (fundamental) frequency, initial peak amplitude (either negative or positive), and location in a time series, as described in Sections 8.1 and 1.3. The resulting shock time series is then superposed on the appropriate Gaussian random background time series. Before this is done, however, the Gaussian signal must have its amplitude reduced to zero in the immediate vicinity of where the shocks are to be located. This allows the true amplitude of the shock to prevail in the time series, without "riding" on the background vibration. This is achieved by using GEDAP program SNIP_GAUSSIAN (see Appendix C). The final record is then produced by combining the shock record and the modified or "snipped" Gaussian record, using GEDAP program ADDXY (Appendix C).

8.3.3 Final preparation of signature

Once a specific acceleration time series has been generated, it is further massaged so that abrupt transitions do not occur on start up, or when the control sequence is put through a repetitive cycle (to construct a long-term exposure). This is achieved by introducing one, or more, transitional blocks of data into the time series, each of which contains 256 elements, and lasts for 2.56 s.

For this reason, a one or two block ramp is constructed at the beginning and end of each exposure. This allows the vibration exciter to reach its full acceleration without unwanted

discontinuities in the motion. The ramp is linear, and is implemented by running GEDAP program RAMP (Appendix C).

In addition, one or two blocks of zero acceleration data, each lasting for 2.56 s, are usually placed at the beginning and end of each signature using GEDAP program APPEND. This allows a brief quiescent period on start-up or between sequence repetitions, and is required by the MARS control software.

The complete signature is next scaled to the appropriate data format using GEDAP program TRANSFORM1, and then converted to ASCII format using GEDAP program EXPORT (proprietary program). Once control signatures have been generated and massaged in this way, for each of the three axes, program TOUSA (Appendix C) correctly formats the output file in a form that can be used by the MARS facility software.

IX Exposures for experiments involving human subjects

The immediate objective of the pilot study, conducted in Phase 3 of the project, is to investigate those biomechanical, physiological and biochemical human responses determined from a review of literature, in Phase 1, to be the most promising for the prediction of injury risk. The pilot tests will include both short-duration exposures (5.5 minutes) and long-duration exposures (1 and 2 hour).

9.1 Short-duration experiments

The short-term experiments are designed to increase understanding of human response to individual impacts in the X, Y and Z directions, separately. The seven 5.5 minute experiments are outlined in table 21. Specifically, human response will be investigated with respect to impact frequency (rise time) and peak amplitudes (conditions 1 to 4), numbers of shocks (condition 5), shock/RMS acceleration magnitude (condition 6) and swept sine wave (condition 7). This last-mentioned exposure will allow comparison with previous work, as well as between sinusoidal and impact vibration.

Current literature documents the effect of vibration amplitude and frequency, especially for sinusoidal vibration. However, comparatively little information is available concerning human response to impacts. The rise time and amplitude experiments are designed to investigate the shock frequency to which the body is most sensitive in each axis, and to determine whether this frequency changes with changing amplitudes of shocks. The exposure involving different numbers of shocks will allow comparison of various impact intervals. It may be determined, for example, that at a particular number of shocks per minute, the muscles respond with constant levels of contraction, rather than characteristic bursts. The experiment investigating the relationship between increasing background vibration and 2.0 g's shocks will help determine the level of background vibration that masks the response to individual impacts.

Each individual shock is presented to the subject two times (e.g. each combination of shock amplitude and frequency in conditions 1-4). This will allow for investigation of variance within an individual. The rise time experiments will have shock amplitudes and frequencies presented to the subject in a random

order, and the time interval between the shocks is also varied. This will help minimize anticipation by the subject. Shock number experiments cannot be randomized. To prevent carry-over effects from the more arduous 30 shock per minute condition, this will be presented last to the subject.

Unfortunately, the original experimental protocol had to be modified as the MARS facility could not produce 4 g impacts below approximately 7 Hz. Maximum shock magnitude was limited to 3 g's with a lower frequency limit of 4 Hz for that shock. The statistical tests (repeated measures analysis of variance) can, therefore, be conducted for frequencies of 4, 6, 8 and 11 Hz. This will allow for investigation of interactions between the variables.

A "warm-up" of approximately 40 seconds is provided at the beginning of each short-term exposure. During this period, two shocks will be presented in a random placement to the subject. No data will be collected for these two shocks. The purpose of this pre-exposure is to provide an accommodation period, under the premise that the human's response to the onset of a shock environment may be somehow different from subsequent shocks.

The six experiments in the short-term exposures require a total exposure time of less than 40 minutes, and will be conducted in one direction during one day. The experiments will involve 10 subjects, and the repeated measures design will allow trends to be determined.

9.2 Long-duration experiments

The long-duration pilot tests are designed to assess the potential fatigue and recovery from the effects of repeated impact over a two-hour exposure period. Seven conditions of two-hour exposures and two conditions of one-hour exposures will provide information about human response to exposures containing different shock magnitudes and numbers.

These experiments have been designed to elicit information in a cross-sectional design as well as a longitudinal design. Responses will be compared between tests of varying signatures as well as throughout individual tests. Indications of fatigue will be investigated in various measurements during the two-hour duration, in addition to recovery following any fatigue. In the two-hour experiments, impacts are presented primarily in the Z direction. In these experiments a small background RMS will be superimposed in the X and Y directions. Condition 7 (table 22)

has impacts presented in the X, Y and Z directions in random order, with a small background vibration in all three directions as well. The one-hour experiments have been added to look specifically at impacts in the Y direction and X direction, in separate exposure conditions. Here a small background RMS is presented in the other directions.

9.2.1 Two-hour exposures

The design of the exposures for the two-hour experiments has been chosen to investigate a number of sub-objectives. The exposure conditions are given in table 22. The first condition is a control experiment with no vibration or shock exposure. All the measures will be analyzed as in the other exposures. This condition is necessary as a baseline, and to determine the effects of fatigue due to the posture adopted by the subject, irrespective of vibration and impact.

Conditions 2-5 are calculated as equivalent in exposure severity according to the VDV in BS 6847 (1987). According to the dose calculations using acceleration at the fourth power (see equations 3.4 and 5.6), exposure to conditions of greater shock amplitude must be accompanied by fewer numbers of shocks. Differences in human response between these four experimental conditions will help us to understand if the calculation procedures of the VDV best account for human responses, or if a different exponent may prove more accurate. For example, the current ISO standard is based on the second power of acceleration, whereas the DRI calculation for exposure to repeated impact is based on the eighth power (See Sections III and IV).

The sixth experimental condition has been designed to test the relationships between shock amplitude and number. It contains 2.0 g's shocks, as in condition 4, but the sixth condition has an increased number of shocks, 32 per minute, to give twice the VDV of condition 4. The sixth condition will also be compared with condition 3 (1.0 g's shocks at 32 per minute), which contains the same number of shocks but a lower amplitude, such that condition 6 again has twice the VDV. These comparisons will enable evaluation of the role of amplitude and number of shocks in human response.

Condition 7 incorporates 1.0 g's impacts randomly in each of the X, Y and Z directions. This condition will allow evaluation of the stress induced by impacts in different axes. Since the shocks occur in all three directions, the Z direction VDV is lower in this condition than in the others. The British Standard

recommends calculating and evaluating the VDV separately in each direction. However, the actual amplitude and number of shocks is identical to condition 3, and theoretically the severity, or dose (if all axes are identical), would be the same. If the same frequency weighting were applied to all three axes, then the VDV of these exposures would be identical to the others.

Data will be collected intermittently during the two-hour (and one-hour) experiments, for example, for 4.5 minutes every 10 minutes prior to, during and following exposure to shock and vibration. The objective is to evaluate changes with time, as well as between experimental conditions. For example, muscle fatigue will be evaluated by electromyography (EMG) over the two-hour exposure and compared between conditions of no vibration or shock, vibration only, and the combinations of vibration and shock at different amplitudes and numbers of shocks.

9.2.2 One-Hour Experiments

The one-hour experiments are designed to investigate shocks in the X and Y directions in a limited study. The exposure conditions are listed in table 23. Results of these experiments will be compared with the first hour of the two-hour experiments with similar shock magnitude (1.0 g's) and number (32 shocks per minute). The severity of shock input at the seat for the one-hour experiment will be the same as the first hour of the two-hour experiments (conditions 2-5, and 7). As with the two-hour experiments, cross-sectional and longitudinal differences will be investigated.

9.3 Vibration and shock during experiments

The shock and vibration magnitudes have been based on those found in data from TGVs, discussed in Part B of this report. The RMS background acceleration, shock amplitudes and rise times, and numbers of shocks per minute reflect typical military exposures driving on a variety of ground surfaces, particularly those encountered during cross-country operations. The shocks are all of type +2 (or -2). The long-term signatures include both positive and negative shocks presented randomly. All have a basic frequency (rise time) of 6 Hz. The short-term signatures have only positive shocks, but the frequencies vary between 2 and 11 Hz.

The levels do not exceed those found in normal training environments. Additionally, vibration and shock magnitudes have

been compared with the current international standard ISO 2631 (1985), and the ASCC guide for "Human tolerance to repeated shock" (Air Standardization Coordinating Committee, 1982). The ISO Standard is reflected in MIL STD 1472C and is the most internationally recognized standard for human exposure to vibration. All short-term, and all but one long-term, experimental exposures on the MARS facility fall within the "exposure limit" guidelines of ISO 2631 (1985).

The ISO standard, although widely used, is limited in its applicability to exposures containing repeated impact. For this reason we also refer to the ASCC guide for human tolerance to repeated shock. The DRI curves in the ASCC guidelines suggest maximal magnitudes and numbers of shocks that can safely be sustained during a 24 hour period. Curves in the ASCC guideline suggest levels of 5% injury risk, severe discomfort and moderate discomfort (see figure 8). Experimental exposures have been designed to be well below the limits of 5% injury risk and also below the levels of severe discomfort.

9.4 Exposure signatures

The seven short-term exposure signatures are presented in Figures 38-43. VDV values and RMS accelerations for each of the 7 short-term experiments are given in Table 24.

The six two-hour experiment signatures are shown in Figures 44-49. VDV values and RMS accelerations for the six exposures are given in Table 25.

The one-hour experiments have the same amplitude and number of shocks as condition 2 in table 25 (1 g's amplitude at 32 shocks per minute). The VDV and RMS accelerations for the one-hour experiments differ from those for the Z direction, owing to the frequency weighting contained in the British standard. The VDV and RMS, respectively, are 18.4 $m \cdot s^{-1.75}$ and 0.93 $m \cdot s^{-2}$. If the same weighting were applied to all three axes, then the VDV of these exposures would be identical to condition 2 after one hour. This unweighted equivalence was chosen so as not to commit the experimental design to the frequency weightings contained in the British standard.

All exposure signatures have been successfully implemented on the MARS facility.

Conclusions

1. A conceptual framework has been developed with which to quantify the salient parameters of seat motion in TGVs, and to integrate these parameters into measures of shock and vibration exposure.

2. The essential elements of a dose model for quantifying health effects resulting from exposure to repeated shocks and vibration, including the potential for biological recovery processes, have been identified in a form suitable for machine computation.

3. A procedure involving computer recognition of impulses, including shocks, and other transient or non-stationary motions within a background of Gaussian random, or near-sinusoidal, vibration has been developed and used to classify TGV seat motion into four types: 1 - Gaussian random motion; 2 - periodic deterministic motion; 3 - intermittent motion; and 4 - impulsive motion, including shocks.

4. The ranges of mean RMS accelerations, frequency weighted according to BS 6841 (1987), observed for type 1 and type 2 seat motions in the X direction of TGVs were from 0.08 to 0.69 $m \cdot s^{-2}$, and from 0.11 to 2.01 $m \cdot s^{-2}$, respectively. The corresponding ranges of mean RMS accelerations in the Y direction were from 0.09 to 0.57 $m \cdot s^{-2}$, and from 0.08 to 0.60 $m \cdot s^{-2}$; and in the Z direction, from 0.11 to 2.53 $m \cdot s^{-2}$, and from 0.15 to 3.14 $m \cdot s^{-2}$, respectively.

5. A classification of shock waveforms by initial peak amplitude, fundamental frequency, and decay rate has been developed and used to analyze the shocks recorded at the seats of TGVs, from which representative shocks may be deduced. In this classification, a type +2 shock consists of an initial positive motion, with amplitude greater than 1.0 g's, followed by oscillatory motion that include one more discernable positive oscillation.

6. The most commonly observed shock in the Z direction during cross-country operation of TGVs was a type +2 shock. The fundamental frequency of this shock waveform ranged from 0.95 to 6.0 Hz, and there were a minimum of three such shocks a minute, and a maximum of eight per minute. The maximum (peak) positive acceleration observed was 6.5 g's, and maximum (peak) negative acceleration was -2.0 g's.

7. The most commonly observed shock in the X direction during cross-country operation of TGVs was a type +1 shock. The

fundamental frequency of the shock waveform ranged from 1.0 to 60 Hz, and there were a minimum of 20 such shocks a minute, and a maximum of 60 per minute. The maximum (peak) positive acceleration observed was 3.7 g's, and maximum (peak) negative acceleration was -3.0 g's.

8. The most commonly observed shock in the Y direction during cross-country operation of TGVs was also a type +1 shock. The fundamental frequency of the shock waveform ranged from 0.8 to 40 Hz, and there were a minimum of 11 such shocks a minute, and a maximum of 29 per minute. The maximum (peak) positive acceleration observed was 2.7 g's, and maximum (peak) negative acceleration was -1.4 g's.

9. The shock and vibration environment at the seats of TGVs has been simulated by combining two signals: one to characterize the shocks, and the other to characterize the near-continuous background vibration. The former has been synthesized by a +2 or -2 type shock, and the latter by a pseudo-random time series with a Gaussian amplitude probability density distribution.

10. Exposure signatures have been created from the two types of signals and successfully run on the MARS facility, for use in the pilot laboratory experiments. Shock and vibration signatures have been constructed in which the amplitude, rise time (frequency), number of shocks per minute, and background level have been varied. Shock amplitudes range from 0.5 g's to 3.0 g's, with rise times of 2-11 Hz, and 1 shock per 2.5 minutes (at 3 g's) to 32 shocks per minute (at 1.0 g and 2.0 g's). Short term (5.5 minutes) experiments have been designed to evaluate the effects of these variables on human response. A series of long term (1 and 2 hour) experiments have been designed to evaluate fatigue effects of repetitive shock environments.

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Table 1
Relationships between even order moments and roots, their corresponding root mean values and the RMS value, for random (Gaussian) vibration

Moment & Root Order, m	Root Mean Value	Relation to RMS	Probability, $P(a)$
2	$a_{(RMS)}$	1.00	0.68
4	$a_{(RMQ)}$	1.32	0.81
6	$a_{(RMX)}$	1.57	0.88
8	$a_{(RMO)}$	1.79	0.93
10	$a_{(RMD)}$	1.98	0.95
12	$a_{(RMT)}$	2.16	0.97

Note that all odd-powered moments of a Gaussian distribution with zero mean value are identically equal to zero.

Table 2
Values of parameters for single degree-of-freedom biodynamic model

Source	Natural Frequency		Damping Ratio
	ω_n (rad.s^{-1})	f_n (Hz)	ζ
Fairley and Griffin (1989)	31.4	5.0	0.475
Payne (1975)	52.9	8.42	0.224

Table 3
Definition of root mean and integrated dose values, for equal even order moments m and roots r

Moment & Root Order, m,r	Root Mean Value	Corresponding Dose Measure	Dose In Terms Of Root Mean Value
2,2	$a_{W(RMS)}$	$\left\{\int_0^T [a_W(t)]^2 dt\right\}^{1/2}$	$a_{W(RMS)}[T]^{1/2}$
4,4	$a_{W(RMQ)}$	$\left\{\int_0^T [a_W(t)]^4 dt\right\}^{1/4}$	$a_{W(RMQ)}[T]^{1/4}$
6,6	$a_{W(RMX)}$	$\left\{\int_0^T [a_W(t)]^6 dt\right\}^{1/6}$	$a_{W(RMX)}[T]^{1/6}$
8,8	$a_{W(RMO)}$	$\left\{\int_0^T [a_W(t)]^8 dt\right\}^{1/8}$	$a_{W(RMO)}[T]^{1/8}$
10,10	$a_{W(RMD)}$	$\left\{\int_0^T [a_W(t)]^{10} dt\right\}^{1/10}$	$a_{W(RMD)}[T]^{1/10}$
12,12	$a_{W(RMT)}$	$\left\{\int_0^T [a_W(t)]^{12} dt\right\}^{1/12}$	$a_{W(RMT)}[T]^{1/12}$

Table 4
Computer programs developed for data analysis

1.	Program FILTV2.FOR
2.	Program BIODYN.FOR
3.	Program CREST3.FOR
4.	Program IMPULSE.FOR
5.	Program ISO.FOR
6.	Program SPECF.FOR
7.	Program APPEND.FOR
8.	Program MULTIXY.FOR
9.	Program SHOCK.FOR
10.	Program SNIP GAUSSIAN.FOR
11.	Program ADDXY.FOR
12.	Program RAMP.FOR
13.	Program TOUSA.COM

Table 5
Vehicles tested at W.E.S.

Vehicle	Description	Weight (lb.)	Speed Range (mph)
Fast Attack Vehicle (FAV)	Light Weight, Highly Mobile Armed Attack Vehicle	2,750	0-50
M2-Bradley	Armored Fighting Vehicle	60,300	0-35

Table 6
Letourneu ride course at W.E.S.

Ride Course Number	Average RMS Roughness (in.)
1	0.9
2	0.6
3	0.2
4	1.4
5	1.2
6	2.0
7	3.0

Table 7
Vehicles tested at Aberdeen proving grounds

Vehicle	Description	Weight (lb.)	Speed Range (mph)
M1A1	Fully Tracked, Low Profile, Armored Primary Assault Weapon	120,000	0-45
M1A1 HTT	M1A1 Variant	120,000	0-45
M1026 HMMWV	High Mobility, Multi-Purpose Wheeled Vehicle	10,000	0-50
M109A3	Self-Propelled Howitzer	53,000	0-35
M923A2	5-Ton Cargo Truck	21,750	0-60
XM1076	N/A	N/A	0-25
M2HS Bradley	Bradley Fighting Vehicle Variant	63,000	0-35

Table 8
Ride courses at Aberdeen proving grounds

Test Course	Course Composition	Length (ft.)
Paved	Bituminous Concrete	2,235
Gravel	Compacted Bank Gravel	10,714
2-Inch Wash-Board	Concrete	822
6-Inch Wash Board	Concrete	798
Radial Wash-Board	Concrete	243
Belgian Block	Granite Blocks in Concrete	3,940
Secondary A	Native Soil	2.4 miles
Cross-Country #1	Moderate: Loam and Gravel	5.2 miles
Cross-Country #2	Moderate to Rough: Loam and Gravel	1.8 miles
Cross-Country #3	Rough: Loam	3.3 miles
Cross-Country #4	Severe: Loam with Marsh	2.5 miles
Churchville B	Hilly Cross-Country Grades up to 29% Rough native soil & stone	5.0 miles

Table 9
Higher-order root mean and dose measures used in the analysis of data

Moment & Root m,r	Root Mean Value	Definition of Root Mean	Corresponding Dose
2,2	$a_{w(RMS)}$	$\left\{\frac{1}{nN}\sum_{u=1}^{nN}[a_w(i)]^2\right\}^{1/2}$	$\left\{\frac{T}{nN}\sum_{u=1}^{nN}[a_w(i)]^2\right\}^{1/2}$
4,4	$a_{w(RMQ)}$	$\left\{\frac{1}{nN}\sum_{u=1}^{nN}[a_w(i)]^4\right\}^{1/4}$	$\left\{\frac{T}{nN}\sum_{u=1}^{nN}[a_w(i)]^4\right\}^{1/4}$
6,6	$a_{w(RMX)}$	$\left\{\frac{1}{nN}\sum_{u=1}^{nN}[a_w(i)]^6\right\}^{1/6}$	$\left\{\frac{T}{nN}\sum_{u=1}^{nN}[a_w(i)]^6\right\}^{1/6}$
8,8	$a_{w(RMO)}$	$\left\{\frac{1}{nN}\sum_{u=1}^{nN}[a_w(i)]^8\right\}^{1/8}$	$\left\{\frac{T}{nN}\sum_{u=1}^{nN}[a_w(i)]^8\right\}^{1/8}$
10,10	$a_{w(RMD)}$	$\left\{\frac{1}{nN}\sum_{u=1}^{nN}[a_w(i)]^{10}\right\}^{1/10}$	$\left\{\frac{T}{nN}\sum_{u=1}^{nN}[a_w(i)]^{10}\right\}^{1/10}$
12,12	$a_{w(RMT)}$	$\left\{\frac{1}{nN}\sum_{u=1}^{nN}[a_w(i)]^{12}\right\}^{1/12}$	$\left\{\frac{T}{nN}\sum_{u=1}^{nN}[a_w(i)]^{12}\right\}^{1/12}$

Table 10
Types of seat motion

Type 1	Gaussian random motion	2.0 < RMT/RMS < 2.5 and I(0.97) < 2.3 and SPECF < 4.0
Type 2	Periodic deterministic motion, typically dominated by tonal (narrow band) components; may be amplitude modulated	either RMT/RMS $\leq$ 2.0; or 2.0 < RMT/RMS < 2.5 and I(0.97) < 2.3 and SPECF $\geq$ 4.0
Type 3	Intermittent motion - non-stationary random and transient deterministic signals	either RMT/RMS $\geq$ 2.5 and I(0.97) > 2.6; or 2.0 < RMT/RMS < 2.5 and I(0.97) $\geq$ 2.3
Type 4	Impulsive motion including shocks	RMT/RMS $\geq$ 2.5 and I(0.97) $\leq$ 2.6;

where:

$$\frac{\mathrm{RMT}}{\mathrm{RMS}} = \frac{a_{W(RMT)}}{a_{W(RMS)}} = \frac{\left\{\frac{1}{nN}\sum_{u=1}^{nN}[a_W(u)]^{12}\right\}^{1/12}}{\left\{\frac{1}{nN}\sum_{u=1}^{nN}[a_W(u)]^{2}\right\}^{1/2}}$$

$$\mathrm{I}(0.97) = I_{P(0.97)} = \frac{([a_W^+]_{P(0.985)} - [a_W^-]_{P(0.015)})}{2a_{W(RMS)}}$$

$$\mathrm{SPECF} = \frac{[A_{W(RMS)}(\omega_k)]_{\max}}{\frac{1}{n}\sum_{k=1}^{n} A_{W(RMS)}(\omega_k)}$$

Table 11
Summary of motion recorded in the Z-direction at the commander's seat of the M2HS Bradley

VEHICLE:		LOCATION:		VIBRATION COMPONENT:				DATE OF ANALYSIS:				ANALYSIS METHOD:			
M2HS Bradley		Commander		Z				Oct. 3, 1992				British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	Dose (norm @ 60 sec) RMQ	Dose (norm @ 60 sec) RMT
1	2	1.85	2.05	5.90	gravel	5	2.88	1.05	-1.17	0.39	0.49	0.72	3.00	1.36	1.01
3	2	2.07	2.03	5.48	gravel	15	3.53	2.45	-2.20	0.66	0.84	1.36	5.10	2.33	1.91
5	1	2.22	2.17	3.37	gravel	25	3.92	2.35	-2.86	0.66	0.88	1.47	5.14	2.44	2.07
8	1	2.32	2.16	2.84	gravel	35	4.24	2.18	-2.11	0.51	0.68	1.17	3.91	1.88	1.65
9	2	1.86	2.10	3.30	6" wshbrd	5	2.92	1.70	-1.78	0.60	0.76	1.11	4.63	2.11	1.56
11	2	1.98	2.15	3.98	6" wshbrd	15	3.36	5.33	-4.20	1.42	1.82	2.81	10.98	5.07	3.96
13	2	1.74	1.97	5.45	6" wshbrd	25	2.94	5.63	-5.44	1.89	2.30	3.28	14.60	6.40	4.61
14	1	2.03	2.19	3.66	sec-A	5	3.34	1.13	-0.98	0.32	0.42	0.64	2.45	1.16	0.90
16	2	2.18	2.20	5.17	sec-A	15	3.88	2.36	-2.57	0.64	0.85	1.39	4.93	2.36	1.95
19	3	3.24	2.90	3.46	sec-A	25	5.64	1.98	-2.04	0.36	0.61	1.15	2.76	1.70	1.62
20	2	1.85	2.05	6.53	XC #3	5	2.96	1.28	-1.54	0.48	0.60	0.88	3.69	1.67	1.24
22	4	2.54	2.28	3.14	XC #3	15	4.20	4.12	-3.05	0.85	1.18	2.17	6.62	3.29	3.05
23	4	4.48	2.49	2.20	XC #3	20	7.83	20.28	-17.20	2.39	4.50	10.72	18.53	12.53	15.08
24	2	1.96	2.17	5.33	paved	6	3.20	1.16	-1.00	0.34	0.44	0.66	2.61	1.21	0.93
26	2	1.57	1.85	7.43	paved	10	2.44	2.58	-2.58	1.06	1.25	1.66	8.20	3.49	2.33
28	2	1.81	1.99	8.89	paved	14	2.98	2.31	-1.99	0.72	0.90	1.31	5.60	2.50	1.84
30	2	2.00	2.18	8.32	paved	18	3.42	2.70	-2.37	0.74	0.97	1.48	5.75	2.69	2.09
32	2	1.64	1.81	8.97	paved	22	2.87	3.13	-3.18	1.10	1.30	1.80	8.52	3.61	2.54
34	1	2.13	2.18	2.11	paved	26	3.63	1.69	-1.45	0.43	0.57	0.92	3.35	1.58	1.30
36	1	2.18	2.21	3.95	paved	30	3.69	1.93	-1.96	0.53	0.70	1.15	4.08	1.96	1.61
38	1	2.21	2.21	2.75	paved	34	3.74	1.77	-1.69	0.46	0.62	1.02	3.58	1.73	1.44
40	4	2.57	2.28	2.38	paved	38	4.57	1.68	-1.74	0.37	0.53	0.96	2.90	1.46	1.35
42	2	2.27	2.15	4.06	CC #3	10	4.08	3.14	-3.45	0.81	1.07	1.83	6.26	2.97	2.58
44	4	6.80	1.99	1.83	CC #3	20	12.08	15.37	-11.29	1.10	2.54	7.50	8.55	7.06	10.55
SIGNAL TYPE					N % n										
1	mean	2.18	2.19	3.11	25	25.83	3.76	1.84	-1.84	0.48	0.64	1.06	3.75	1.79	1.49
	std. dev	0.10	0.02	0.68		10.98	0.30	0.43	0.64	0.11	0.15	0.28	0.89	0.43	0.39
2	mean	1.91	2.05	6.06	54.17	11.86	3.93	4.79	-4.13	0.87	1.33	2.62	6.78	3.71	3.69
	std. dev	0.20	0.12	1.86		6.59	0.45	1.42	1.25	0.44	0.53	0.76	3.38	1.47	1.07
3	mean	3.24	2.90	3.46	4.17	25.00	5.64	1.98	-2.04	0.36	0.61	1.15	2.76	1.70	1.62
	std. dev	n/a	n/a	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	4.10	2.26	2.39	16.67	23.25	7.17	10.36	-8.32	1.18	2.19	5.34	9.15	6.09	7.51
	std. dev	2.02	0.20	0.55		10.11	3.66	8.90	7.28	0.86	1.76	4.58	6.68	4.89	6.44

Table 12
Mean values of RMS acceleration recorded
in TGVs for type 1 seat motion

	Mean Values for Type 1 Signals (RMS m/sec^2)					
Vehicle/Locations	X	st dev	Y	st dev	Z	st dev
M2HS/Commander	0.10	0.03	0.15	0.06	0.48	0.11
M2HS/Driver	0.18	0.06	0.26	0.07	0.64	0.10
M2HS/Crew	0.40	0.22	0.18	0.11	0.43	0.04
M109/Chief	0.22	0.07	0.21	0.10	0.94	n/a
M109/Driver	0.18	0.12	0.21	0.09	0.47	0.05
M109/Gunner	0.19	0.14	0.20	0.06	0.57	0.10
M1A1HTT/Driver	0.08	0.01	0.09	0.04	0.11	0.03
M1A1/Commander	0.19	0.03	0.33	0.12	0.46	0.09
M1A1/Driver	0.19	0.04	0.21	0.06	0.31	0.20
M1A1/Gunner	0.20	0.04	0.22	0.06	0.35	0.11
M1A1/Loader	0.23	0.03	0.21	0.30	1.22	n/a
M1076/Driver	0.69	0.24	0.57	0.19	1.43	n/a
M923/Unknown	n/a	n/a	0.34	n/a	0.55	0.25
HMMMV/Driver	0.43	0.48	0.13	n/a	1.87	n/a
HMMMV/CurbFront	0.16	0.20	0.10	n/a	0.40	n/a
HMMMV/CurbRear	0.18	0.15	0.35	0.20	1.92	0.39
HMMMV/RoadRear	0.21	0.17	0.39	n/a	2.53	n/a

Table 13
Mean values of RMS acceleration recorded in TGVs for type 2 seat motion

	Mean Values for Type 2 Signals (RMS m/sec^2)					
Vehicle/Locations	X	st dev	Y	st dev	Z	st dev
M2HS/Commander	0.71	1.06	0.14	0.08	0.87	0.44
M2HS/Driver	0.21	0.10	0.60	0.39	1.04	0.76
M2HS/Crew	0.35	0.04	0.23	0.20	1.87	0.94
M109/Chief	0.39	0.31	0.27	0.12	3.14	1.56
M109/Driver	0.36	0.26	0.33	0.16	1.05	0.99
M109/Gunner	0.24	0.25	0.44	0.36	1.19	1.00
M1A1HTT/Driver	0.13	0.10	0.08	0.02	0.15	0.04
M1A1/Commander	0.52	0.38	0.44	0.03	0.86	0.77
M1A1/Driver	0.51	0.34	0.39	0.13	0.56	0.48
M1A1/Gunner	2.01	2.14	0.60	0.03	0.72	0.37
M1A1/Loader	0.64	0.13	0.57	0.30	0.94	0.56
M1076/Driver	1.01	0.42	0.54	0.17	2.06	0.89
M923/Unknown	1.31	1.42	0.32	0.13	1.95	0.60
HMMMV/Driver	0.29	0.29	0.40	0.21	1.20	0.97
HMMMV/CurbFront	0.27	n/a	0.30	0.16	1.26	0.78
HMMMV/CurbRear	0.39	0.13	0.44	0.14	n/a	n/a
HMMMV/RoadRear	0.11	0.10	0.21	0.13	3.04	1.35

Table 14
Shock parameters recorded in the Z-direction at the commander's seat of the M2HS Bradley during cross-country operation

2. SELECTED SHOCKS: XC											
VEHICLE	LOCATION	RECORD #	DIRECTION	DURATION (s)	No. OF SHOCKS	Δ T Min (s)	Δ T Max (s)	SHOCK TYPE	PEAK AMPLITUDE (G) + ve	PEAK AMPLITUDE (G) - ve	FREQ. (Hz)
M2HS	Commander	23	Z	18.5	9	0.5	2.5	-1	1.2	1.5	1.0
		•	•					2	1.8	0.8	2.1
		•	•					-1	1.5	0.8	1.1
		•	•					3	2.0	1.3	1.6
		•	•				0.36	1	3.2	1.0	1.8
	Driver	23	Z	18.5	12	0.25	3.8	4	2.6	3.6	32.0
		•	•					-2	1.5	2.0	21.0
		•	•					-2	2.2	1.6	21.0
		•	•					-2	1.7	1.4	21.0
		23	Y	18.5	9	0.94	3.75	1	1.0	1.0	0.8
		•	•					3	3.0	0.5	1.49
		•	•					1	1.75	0.8	0.8
		•	•					3	1.75	0.8	1.37
		•	•					2	3.0	0.5	1.28
		•	•					1	1.5	1.1	0.8
		•	•					3	1.75	1.0	2.56
		•	•					2	4.0	0.8	4.8
		•	•					1	2.7	0.6	1.07
	LR_Crew	23	Z	18.5	7	1.25	4.063	-2	1.6	1.0	2.13
		•	•					-1	1.0	0.5	2.0
		•	•					2	1.7	1.4	1.6
		•	•					3	1.2	1.0	1.1
		•	•					-2	1.5	1.0	1.6
		•	•					2	2.4	1.1	1.28
		•	•					1	3.7	1.7	0.8
		•	•					-3	1.5	1.2	8.0
		•	•					3	1.2	1.2	8.1
		•	•					-5	1.6	1.0	42.0
		•	•					6	1.2	1.0	41.0
		44	Y	18.5	5	1.09	5	-3	1.5	1.2	8.0
		•	•					3	1.2	1.2	8.1
		•	•					-5	1.6	1.0	42.0
		•	•					6	1.2	1.0	41.0
		•	•					1	1.5	1.4	40.0

Table 15
Summary of shock parameters observed at the seats of tactical ground vehicles in the X-direction

TITLE:	1.0 TYPICAL SHOCKS						
DIRECTION:	X						
SHOCK	% OF TOTAL	PEAK AMP. RANGE (G)		FREQ. RANGE (Hz)		No./min.	
TYPE	SHOCKS	+ ve	- ve	min.	max.	min.	max.
+1	9	1.0	0.5	26.0	26	3	24
+2							
+3							
+4	9	1.5	3.1	43.0	43.0		
-1	55	-3.0	0.7	3.2	9.0		
-2	18	1.8	1.0	8.0	8.0		
-3	9	5.5	4.3	21.0	21.0		
-4							
Total # of shocks with f <60 Hz:		11					

Table 16
Summary of shock parameters observed at the seats of tactical ground vehicles in the Y-direction

TITLE:	1.0 TYPICAL SHOCKS						
DIRECTION:	Y						
SHOCK	% OF TOTAL	PEAK AMP. RANGE (G)		FREQ. RANGE (Hz)		No./min.	
TYPE	SHOCKS	+ ve	- ve	min.	max.	min.	max.
+1	20	1.2	0.1	26.0	26.0	1.0	10.0
+2							
+3	20	5.7	0.2	18.0	18.0		
+4							
-1	20	1.2	0.5				
-2							
-3	20	4.0	2.7	56.0	56.0		
-4							
-9	20	0.8	1.5	26.0	26.0		
Total # of shocks with f <60 Hz:		5					

Table 17
Summary of shock parameters observed at the seats of tactical ground vehicles in the Z-direction

TITLE:	1.0 TYPICAL SHOCKS						
DIRECTION:	Z						
SHOCK	% OF TOTAL	PEAK AMP. RANGE (G)		FREQ. RANGE (Hz)		No./min.	
TYPE	SHOCKS	+ ve	- ve	min.	max.	min.	max.
+1	30	5.0	1.0	0.9	24	3	27
+2	18	3.6	1.5	1.60	7.1	1	5
+3	6	1.5	1.3	1.6	15.0	3	5
+4	9	4.2	1.5	1.6	1.9	3	4
+5	3	2.1	1.7	32.0	32.0	3	3
-1	5	2.1	-	2.1	8.5	3	5
-2	12	2.3	1.8	1.2	3.0	3	5
-3	8	2.5	1.9	2.1	51.0	3	5
-4	3	2.7	1.8	26	26	3	3
-5	3	1.3	1.1	2.7	2.7	3	3
-6	3	1.6	1.0	3.2	3.2	3	3
				All shock types:		4	64
Total # of shocks with f <60 Hz:		33					

Table 18
Summary of shock parameters observed at the seats of tactical ground vehicles in the X-direction during cross-country operation

TITLE:	2.0 CROSS-COUNTRY SHOCKS						
DIRECTION:	X						
SHOCK	% OFTOTAL	PEAK AMP. RANGE (G)		FREQ. RANGE (HZ)		No./min.	
TYPE	SHOCKS	+ve	-ve	min.	max.	min.	max.
+1	60.0	3.7	3.0	1.0	60.0	20.0	60.0
+2							
+3							
+4	10.0	4.0	3.0	-	50.0	20.0	60.0
-1							
-2	10.0	2.5	5.0		60.0	20.0	60.0
-3	10.0	1.5	2.0		40.0		
-4	10.0	1.5	2.5		60.0	20.0	60.0
Total # of shocks with f<60 Hz		10					

Table 19
Summary of shock parameters observed at the seats of tactical ground vehicles in the Y-direction during cross-country operation

TITLE:	2.0 CROSS COUNTRY SHOCKS						
DIRECTION:	Y						
SHOCK TYPE	% OF TOTAL SHOCKS	PEAK AMP. RANGE (G) + ve	- ve	FREQ. RANGE (Hz) min.	max.	No./min. min.	max.
+1	27	2.7	1.4	0.8	40.0	10.67	29.2
+2	11	4.0	0.8	1.28	4.8		
+3	22	2.5	1.8	1.4	12.0		
+4	5.5	1.3	0.5	12.8	12.8		
-1	-	-	-	-	-		
-2	-	-	-	-	-		
-3	5.5	1.5	1.2	8.0	8.0		
-4	11	3.0	1.5	25.60	25.60		
Total # of shocks with f <60 Hz:		18					

Table 20

Summary of shock parameters observed at the seats of tactical ground vehicles in the Z-direction during cross-country operation

TITLE:	2.0 CROSS-COUNTRY SHOCKS						
DIRECTION:	Z						
SHOCK	% OF TOTAL	PEAK AMP. RANGE (G)		FREQ. RANGE (Hz)		No./min.	
TYPE	SHOCKS	+ ve	- ve	min.	max.	min.	max.
+1	14	4.0	1.7	0.8	2.8	3	5
+2	24	6.5	2.0	0.95	6.0	3	8
+3	11	3.2	1.2	1.1	8.1	3	3
+4	4	2.6	3.6	32.0	32.0	3	3
-1	23	2.0	1.5	0.5	2.0	3	6
-2	20	2.2	2.0	1.6	21.0	3	9
-3							
-4	4	1.9	3.0	5.71	5.71	3	3
				All shock types:		19	39
Total # of shocks with f <60 Hz:		30					

Table 21
Exposure conditions for short-duration experiments

Condition Number	Variable	Background rms level	Shock Frequency (rise time)	Shock Amplitude	Time
1	**Rise Time**	0.05g broad band	2, 4, 6, 8, 11	0.5 g	5.5 min
2			2, 4, 6, 8, 11	1g	5.5 min
3			4, 5, 6, 8, 11	2g	5.5 min
4			4, 5, 6, 8, 11	3g	5.5 min
5	**Shock Number** 2/80 sec. 13/80 sec. 40/80 sec.	0.05 g broad band	6 Hz 6 Hz 6 Hz	2g 2g 2g	5.5 min
6	**Background rms/shock relationship** **2 shocks/min.**	0.1g 0.17g 0.25g 0.4g	6 Hz 6 Hz 6 Hz 6 Hz	2g 2g 2g 2g	5.5 min
7	**Response to single amplitude swept sine wave**	0.3g	sinusoidal at 2 Hz to 17 Hz at 1/4 Hz per second	N/A	1.5 min

Table 22
Exposure conditions for two-hour experiments

Number	Z axis rms	X axis rms	Y axis rms	Shock Ampl.	Shock No.
1. Control.	none	none	none	none	none
2. Background rms	0.16g	0.05g	0.05g	none	none
3. shocks + rms	0.05g	0.05g	0.05g	1g z only	32/min.
4. shocks + rms	0.05g	0.05g	0.05g	2g z only	2/min.
5. shocks + rms	0.05g	0.05g	0.05g	3g z only	1/2.5 min.
6. shocks + rms	0.05g	0.05g	0.05g	2g z only	32/min.
7. shocks + rms	0.05g	0.05g	0.05g	1g shocks in X, Y, and Z	32/min. random

Table 23
Exposure conditions for one-hour experiments

Number	Z axis rms	X axis rms	Y axis rms	Shock Ampl.	Shock No.
1. Y rms & shocks	0.05g	0.05g	0.05g	1g in Y	32/min
2. X rms & shocks	0.05g	0.05g	0.05g	1g in X	32/min

Table 24
VDV and RMS accelerations short-duration experiments

Exposure	Description	VDV	RMS (m.s-2)
Rise Time (5.5 min)	0.5g, at 2,4,6,8,11 Hz	3.8	0.64
	1.0g at 2,4,6,8,11 Hz	5.5	0.697
	2.0g at 4,5,6,8,11 Hz	11.01	0.895
	3.0g at 4,5,6,8,11 Hz	22.48	1.44
Shock Number	2g shocks at 6Hz at 2/80 sec, 13/80 sec and 40/80 sec	16.33	1.46
Background rms/shock relationship	2g shocks at 0.1g, 0.17g, 0.25g and 0.4g background rms	20.35	3.11
Swept sine wave	1/4 Hz per second from 2-16 Hz.		

Table 25
VDV and RMS accelerations long-duration experiments

Exposure	**Description**	**VDV (for z-axis)**	**RMS (m.s-2) (for z-axis)**
Background RMS no shocks	0.16g in z-axis, 0.02g in x and y-axes	25.88	2.10
1g shocks and RMS	1g shocks at 32/min.-0.05g rms in z-axis and 0.02g in x and y-axes	24.18	1.36
2g shocks and RMS	2g shocks at 2/min. -0.05g rms in z-axis and 0.02g in x and y-axes	24.3	0.87
3g shocks and RMS	3g shocks at 1/2.5 min - 0.05g rms in z-axis and 0.02g in x and y-axes	24.2	0.73
2g shocks and RMS	2g shocks at 32/min. - 0.05g rms in z-axis and 0.02g in x and y-axes	48.18	2.54

Table 25 (continued)
VDV and RMS accelerations long-duration experiments

Shocks in X, Y and Z	1g shocks in X, Y and Z axes -0.05g rms in z-axis and 0.02g in x and y-axes	18.42 (24.2 if uniform weighting applied in all axes)	0.93

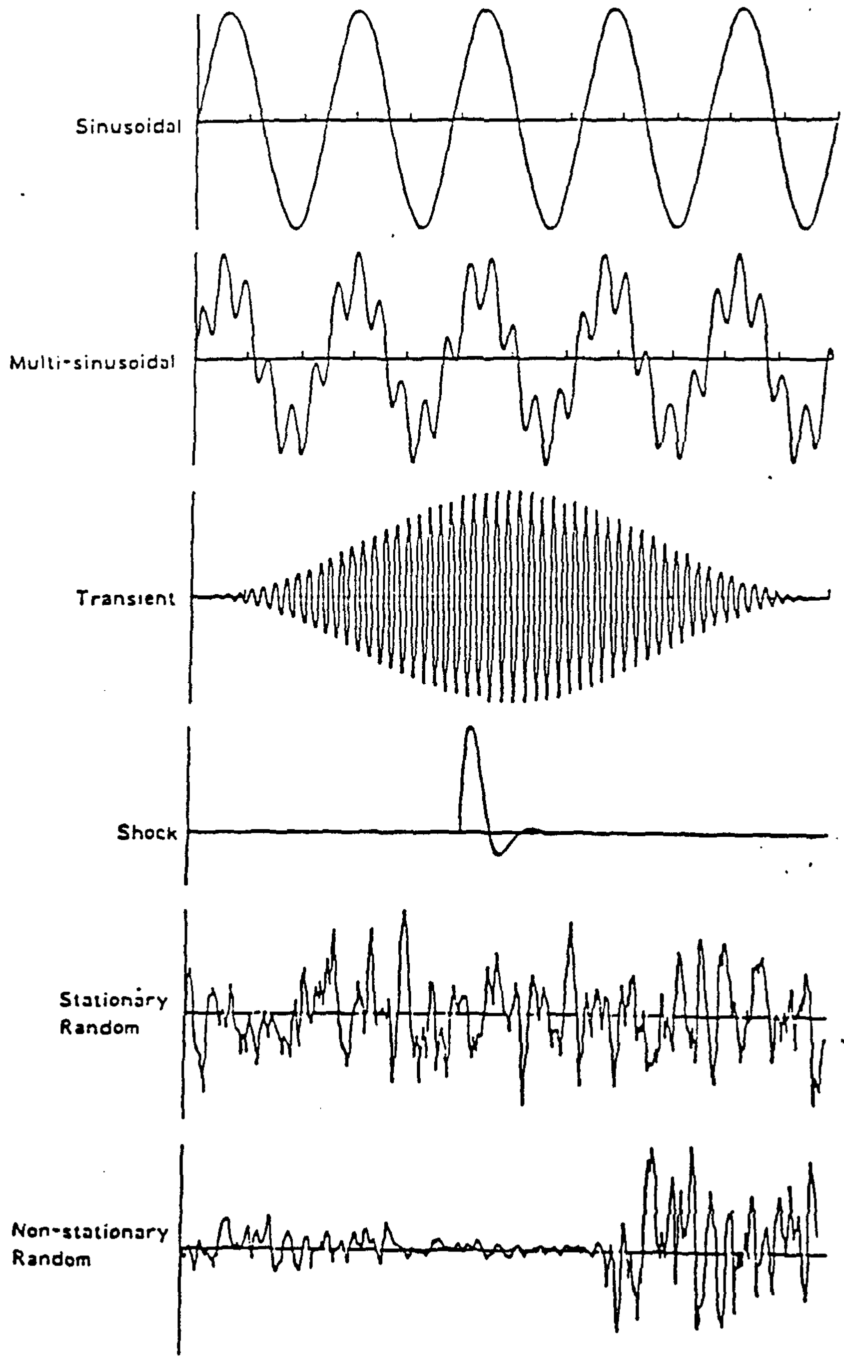


Figure 1
Examples of deterministic and random vibration waveforms, and shocks (after Griffin, 1990).

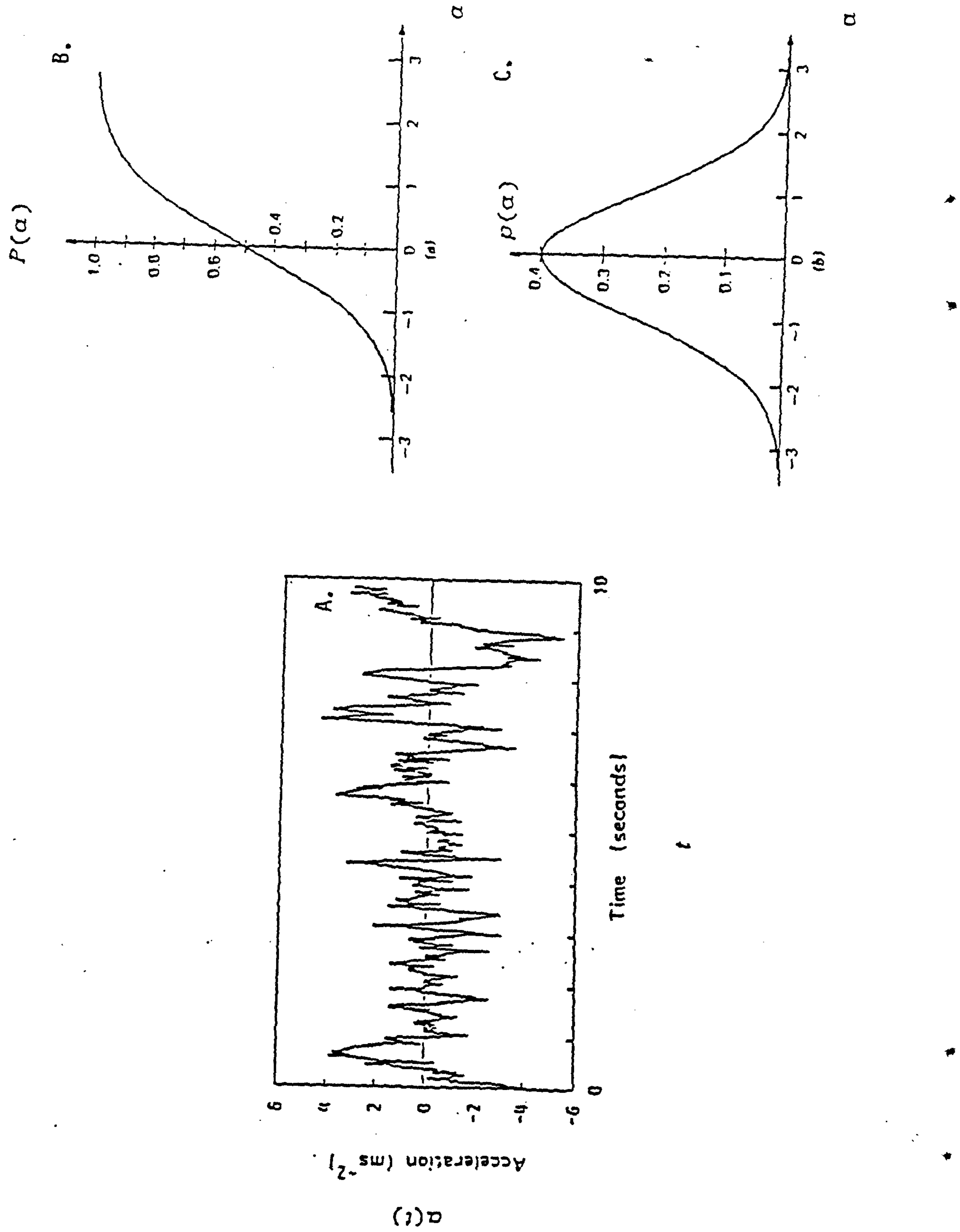


Figure 2
Acceleration wave form $a(t)$ (figure 2A), cumulative acceleration amplitude probability distribution (figure 2B) and acceleration amplitude probability density distribution $p(a)$ (figure 2C) for a random signal with zero mean value.

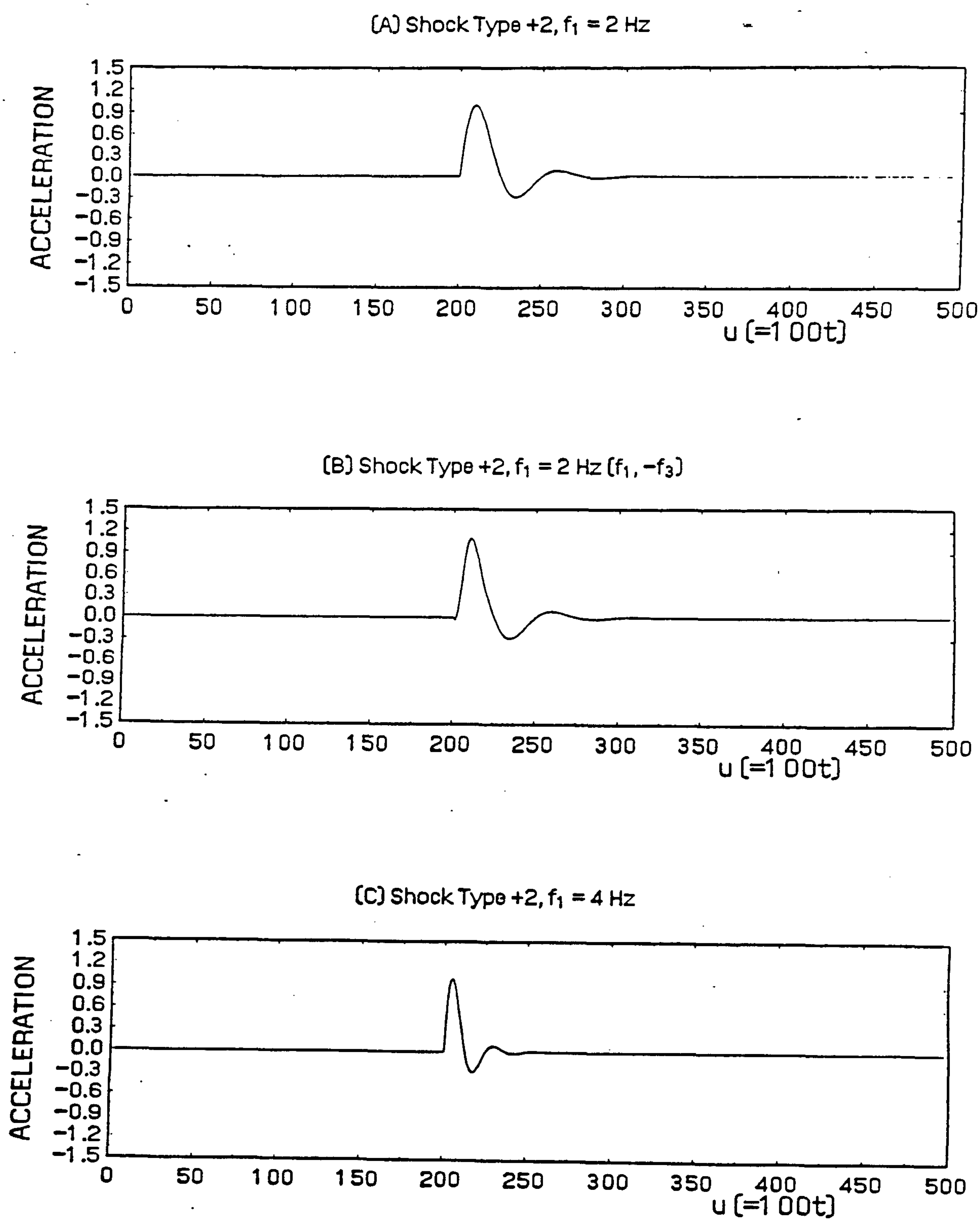


Figure 3
Shock time histories constructed using equation 1.20

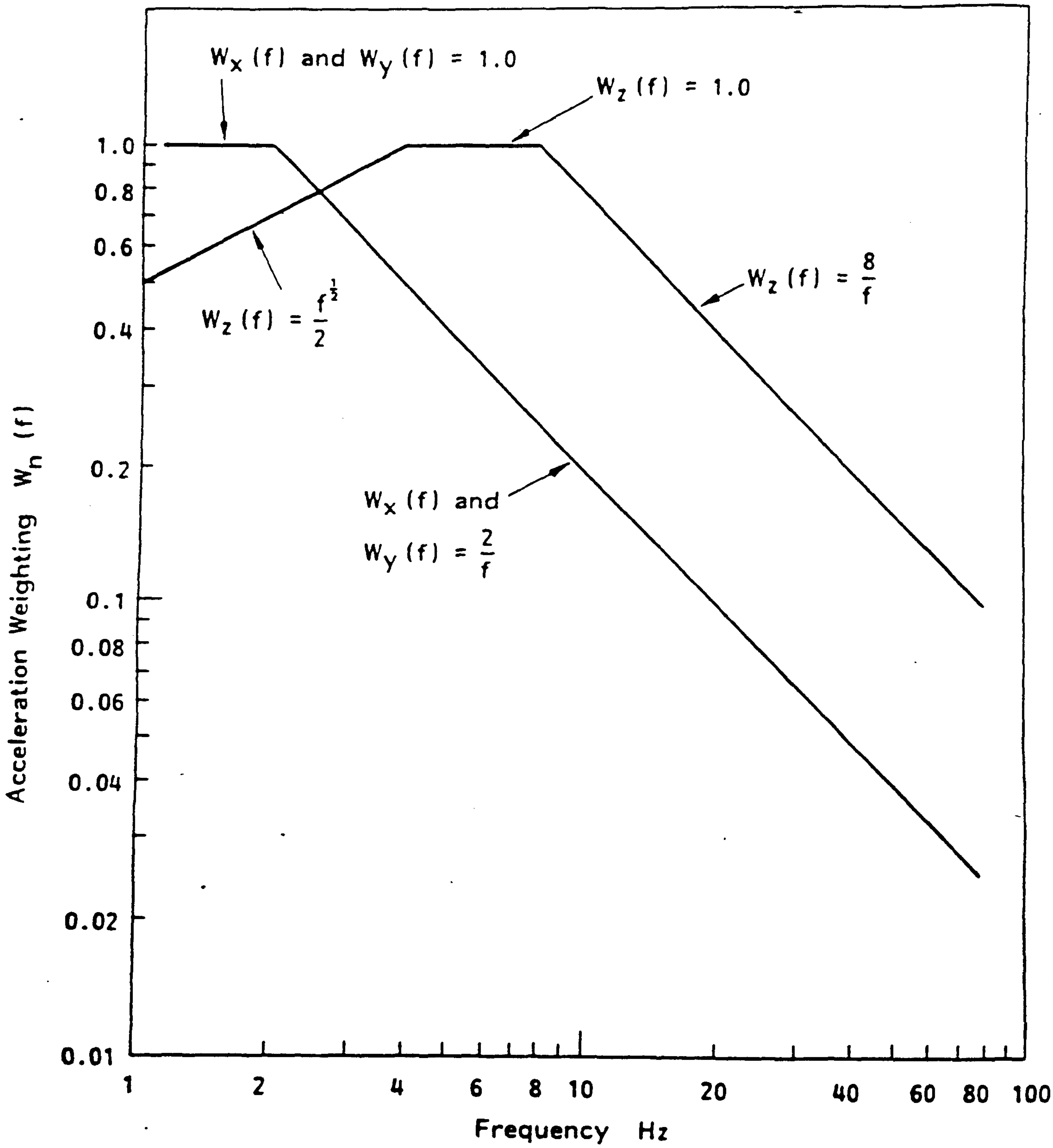


Figure 4
Frequency-weighting functions derived from international standard ISO 2631 (1978) and ISO 2631/1 (1985).

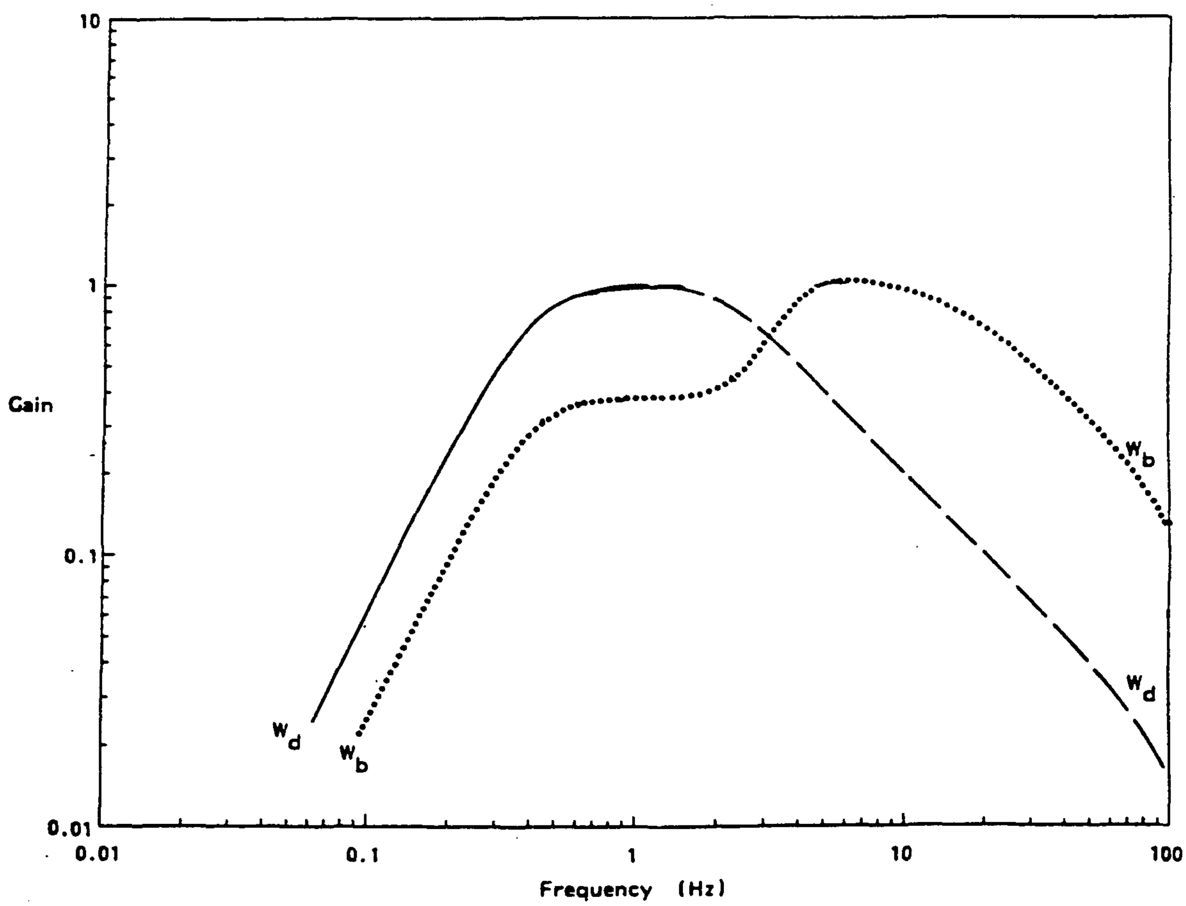


Figure 5
Magnitudes of health-related frequency-weighting functions contained in British standard BS 6841 (1987).

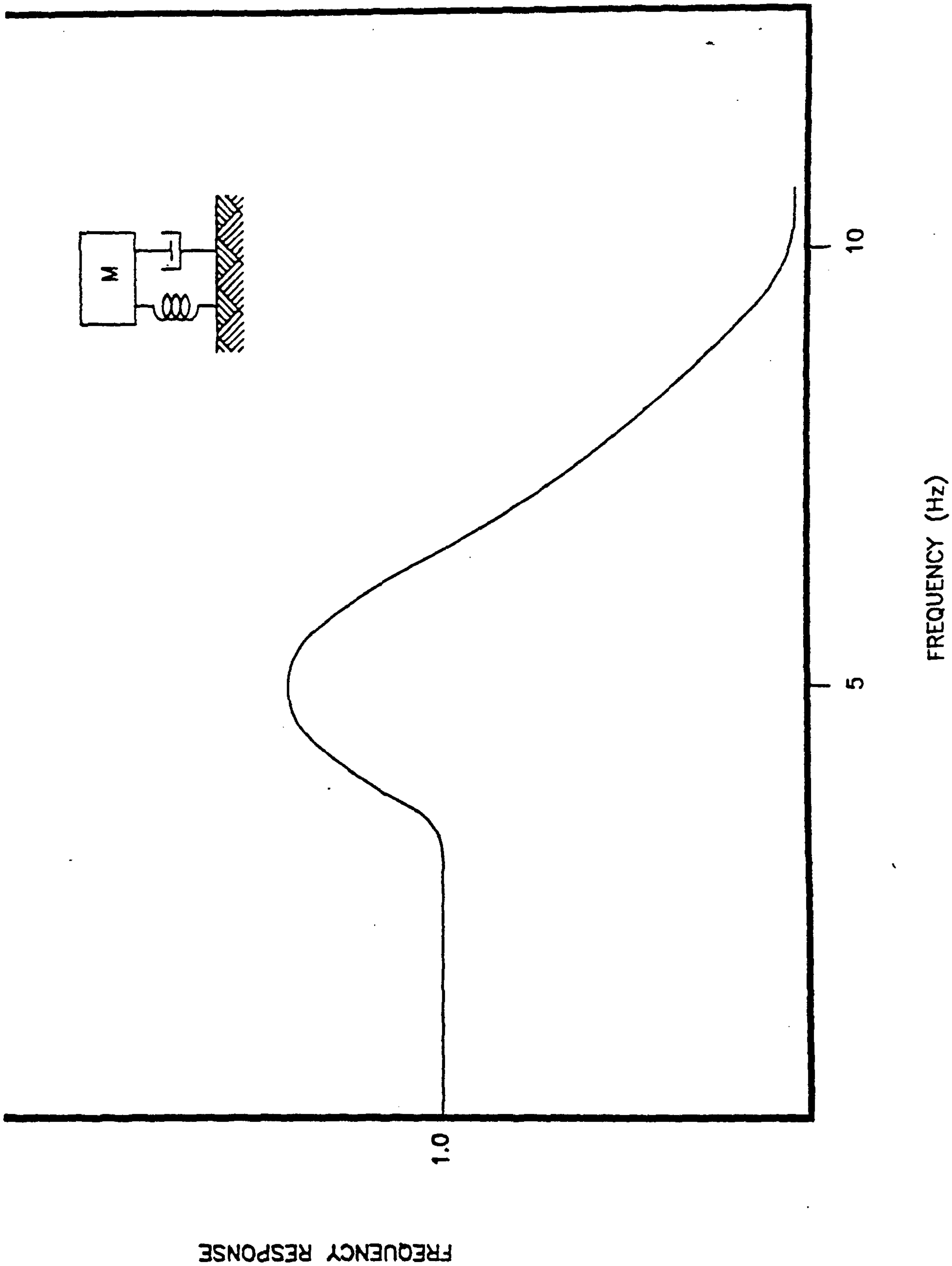


Figure 6
Single degree-of-freedom biodynamic model for human response to vibration and shocks.

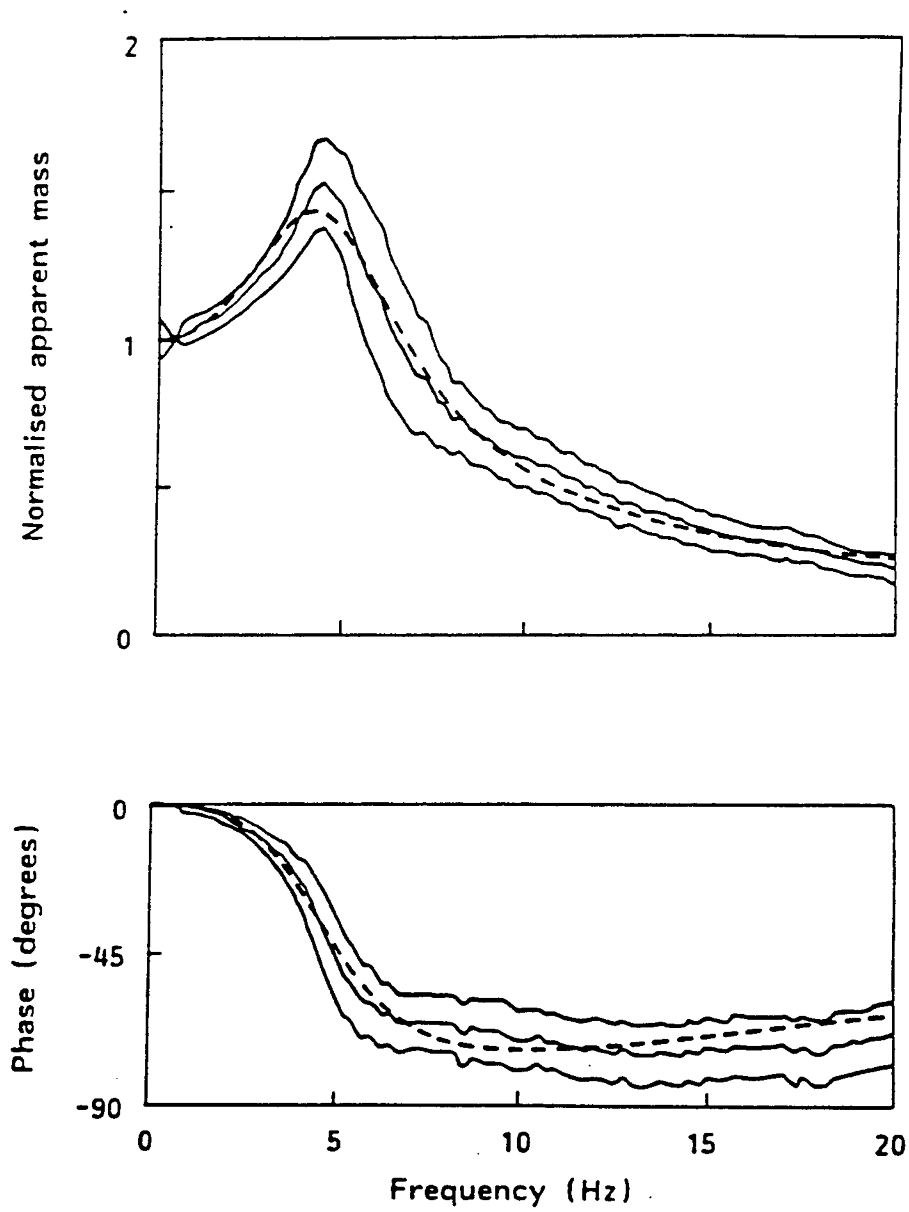


Figure 7
Mean normalized apparent mass of 60 subjects (±1 standard deviation), shown as magnitude and phase, compared with the response of the Fairley and Griffin model (Fairley and Griffin, 1989). [Figure reproduced with permission of *J Biomechanics*]

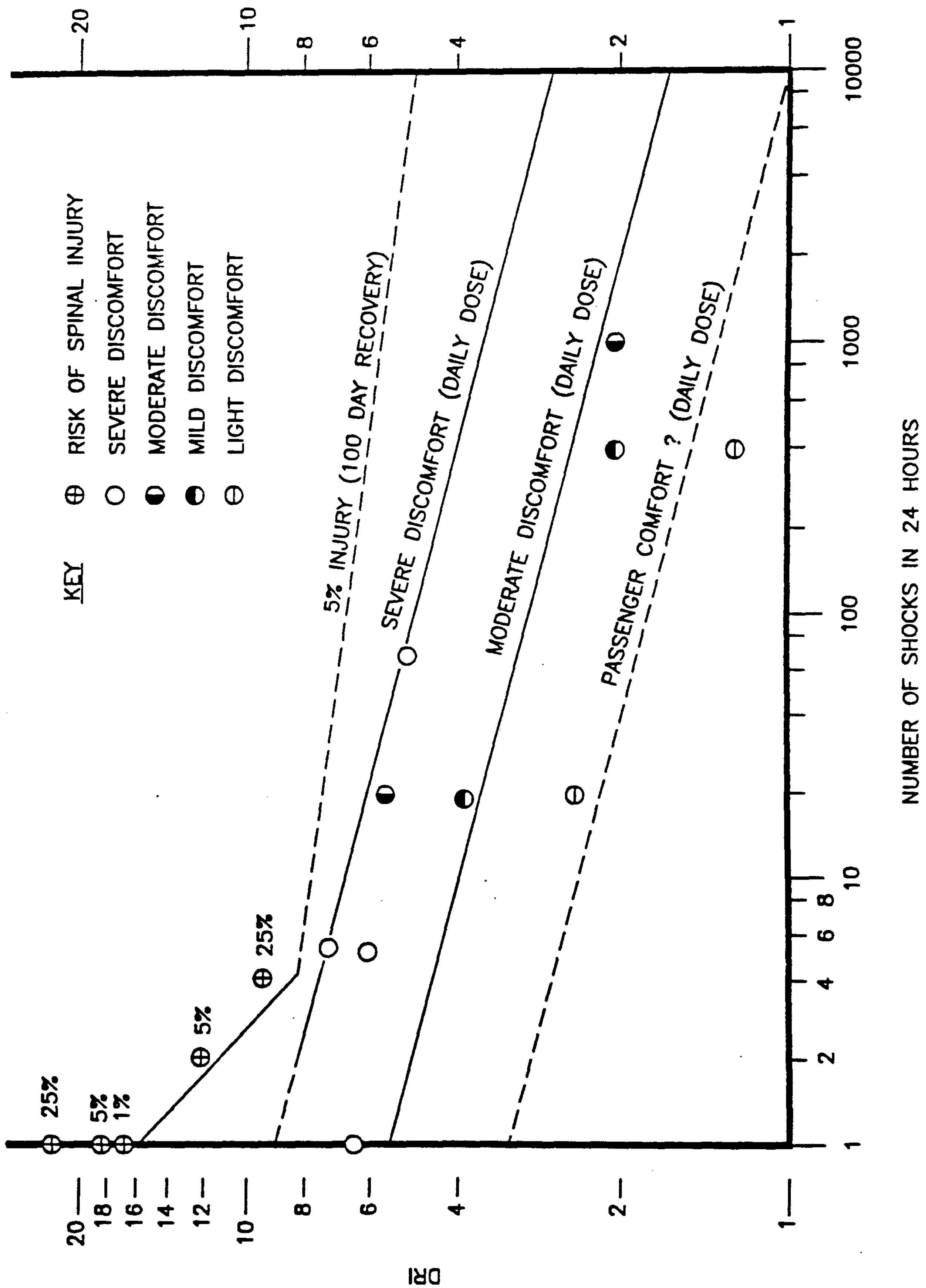


Figure 8
Relationship between exposure to repeated shocks and spinal injury, and discomfort for seated persons (Allen, 1977).

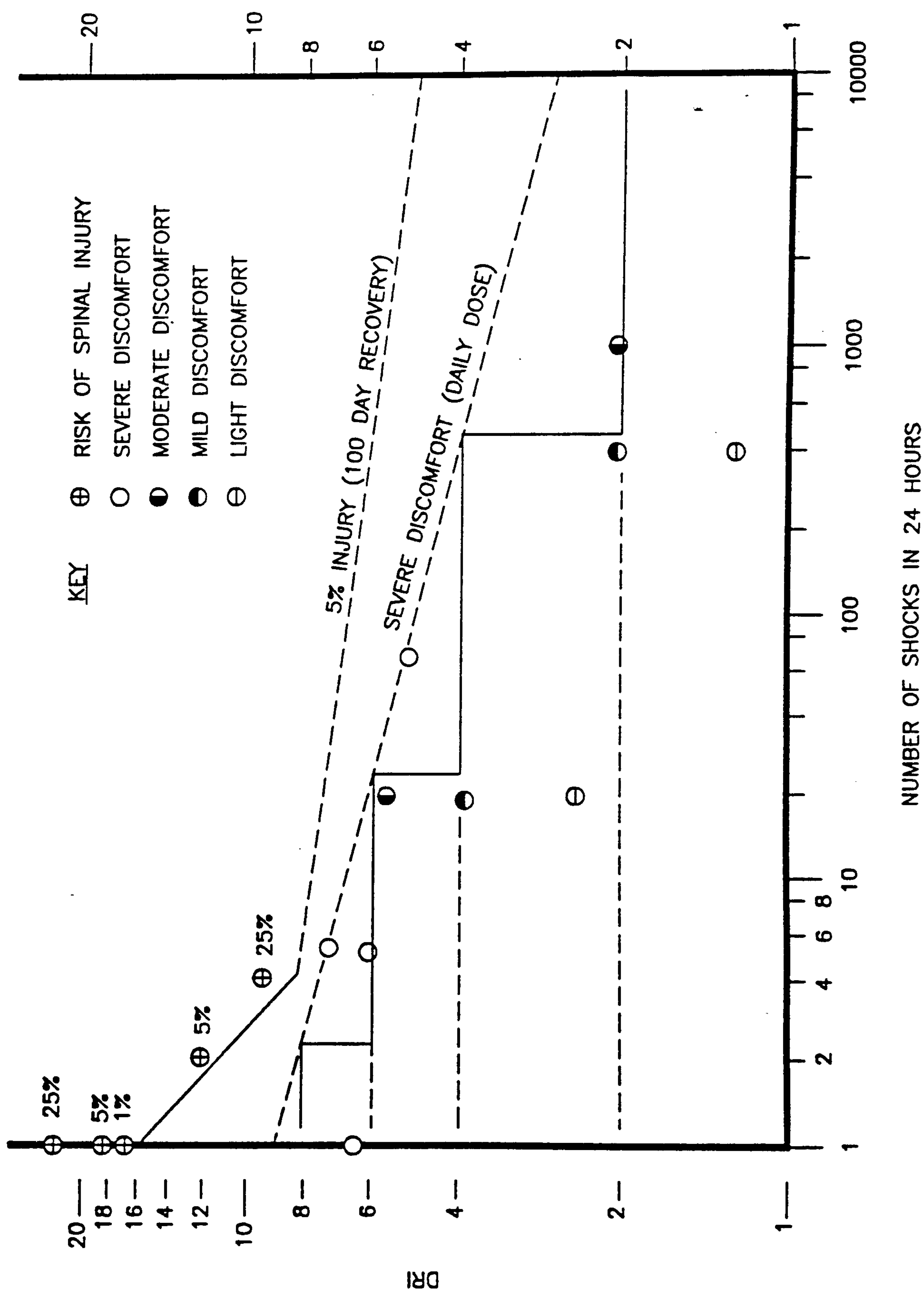


Figure 9
Example of grouping DRI values to construct magnitude windows for assessing the hazard of exposure to multiple shocks.

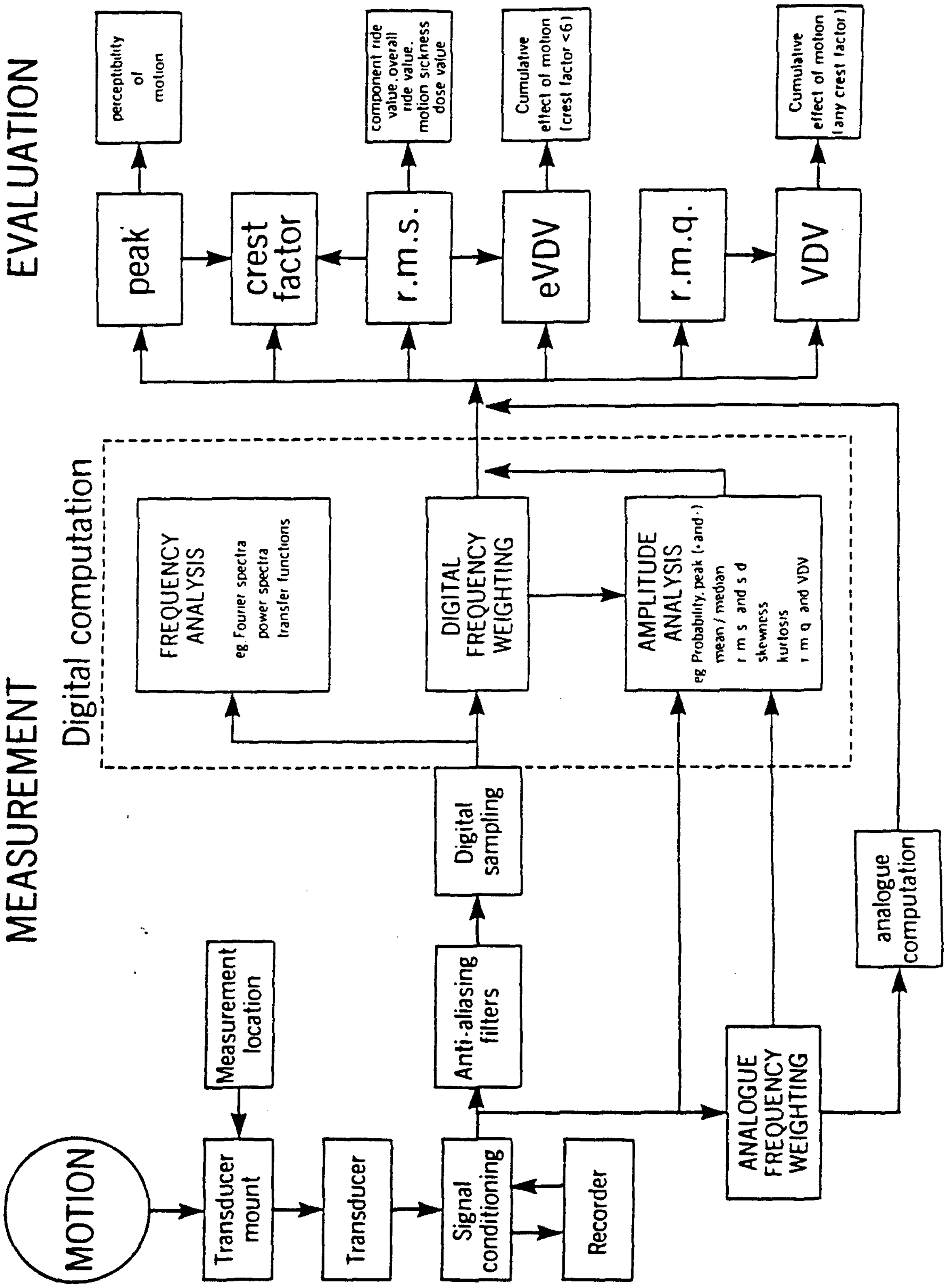


Figure 10
Block diagram of measurement and analysis methodology.

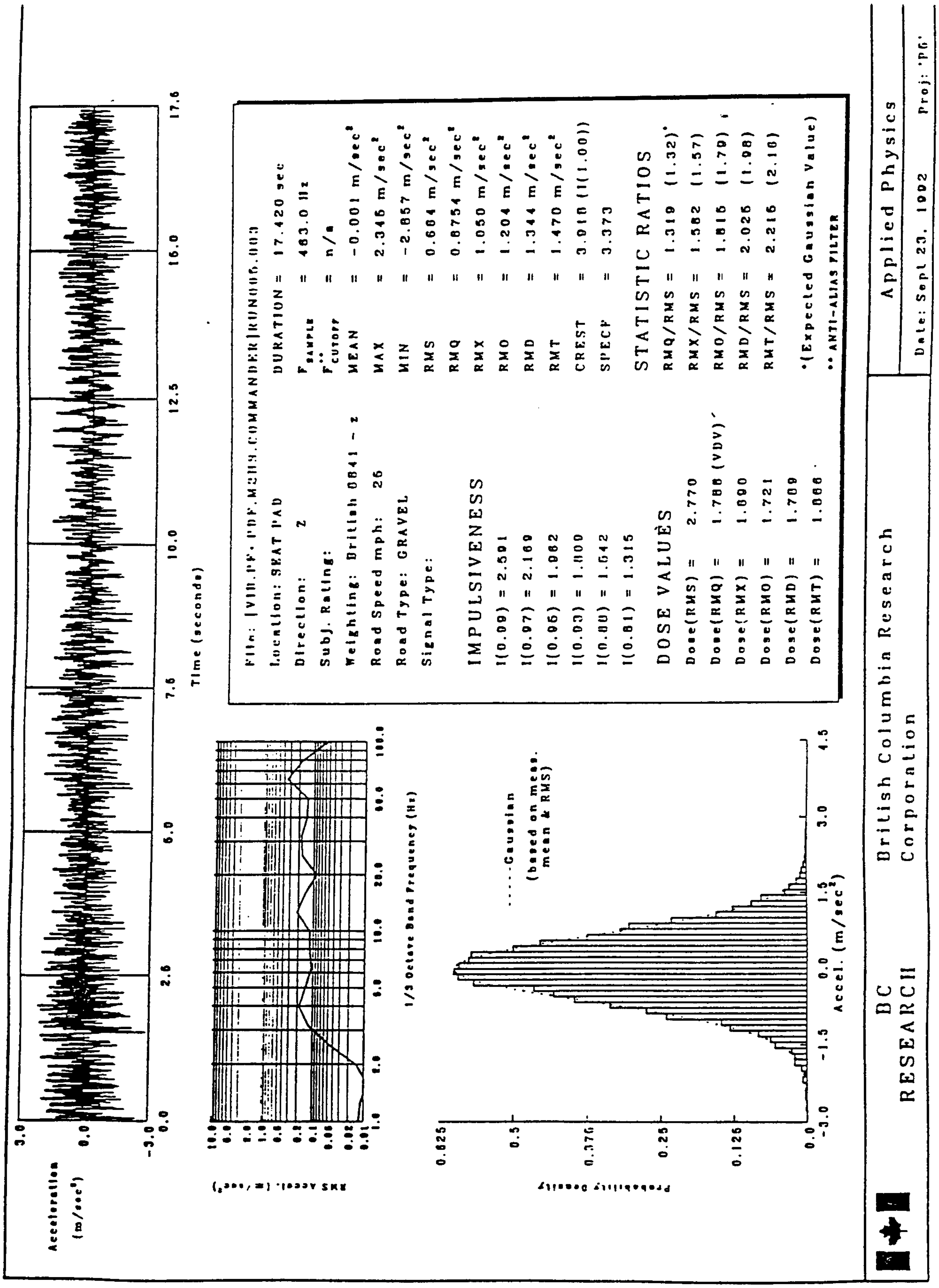


Figure 11
Seat motion analyzed using frequency weighting in British standard, BS 6841 (1987). Signal type 1: Gaussian random motion

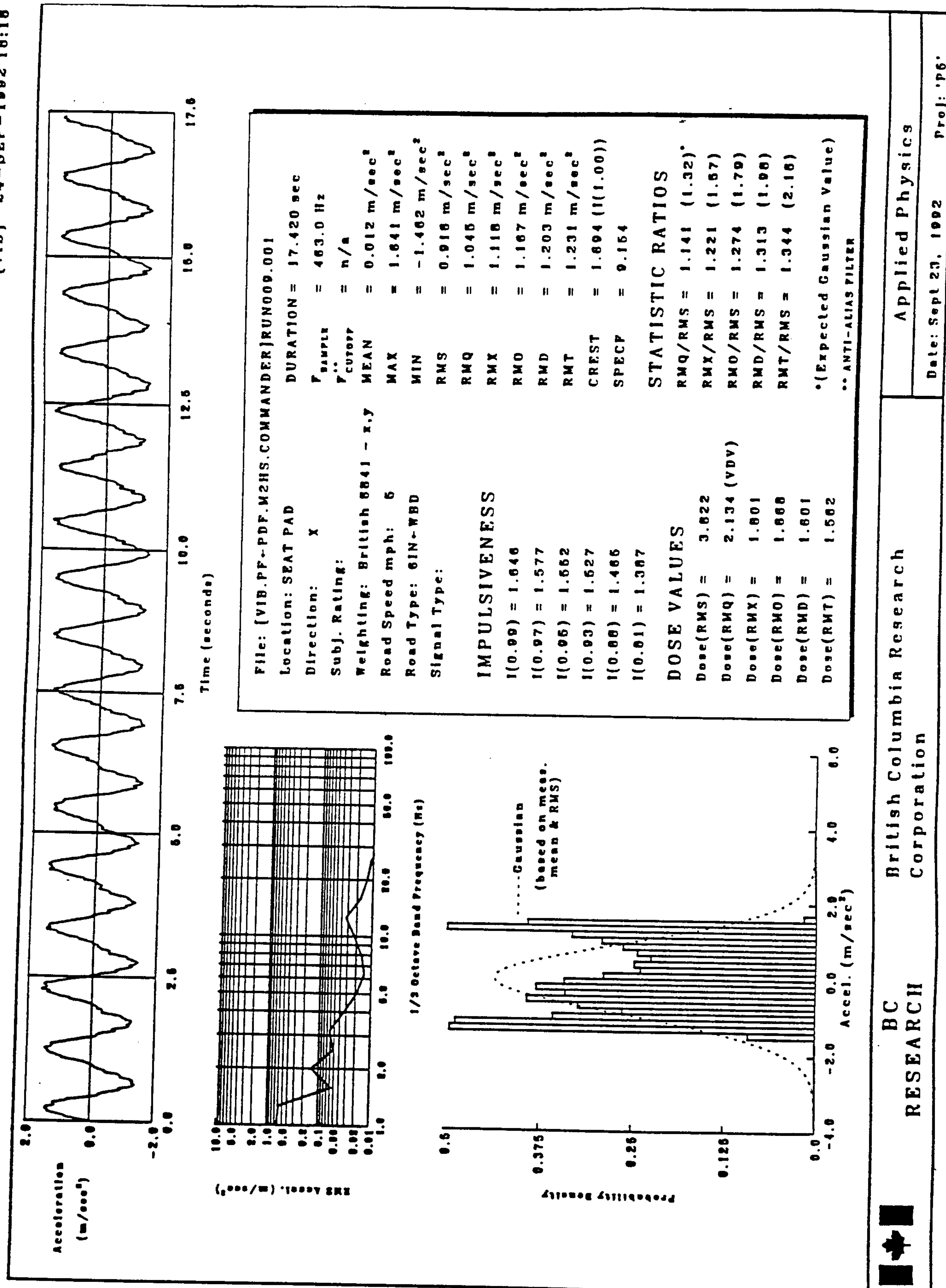


Figure 12
Seat motion analyzed using frequency weighting
in British standard, BS 6841 (1987).
Signal type 2: Near sinusoidal low-frequency motion

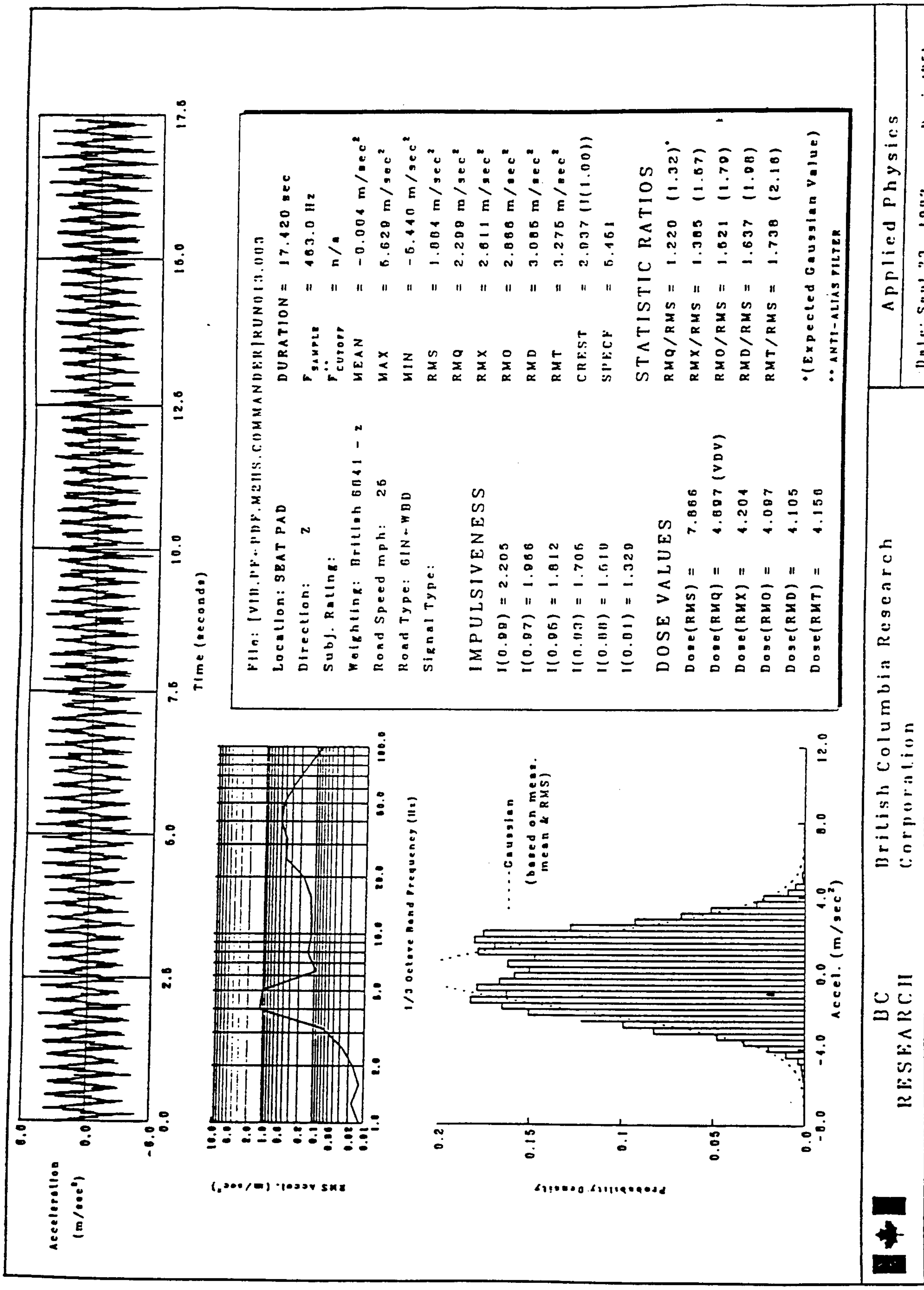


Figure 13
Seat motion analyzed using frequency weighting in British standard, BS 6841 (1987).
Signal type 2: Near sinusoidal high-frequency motion

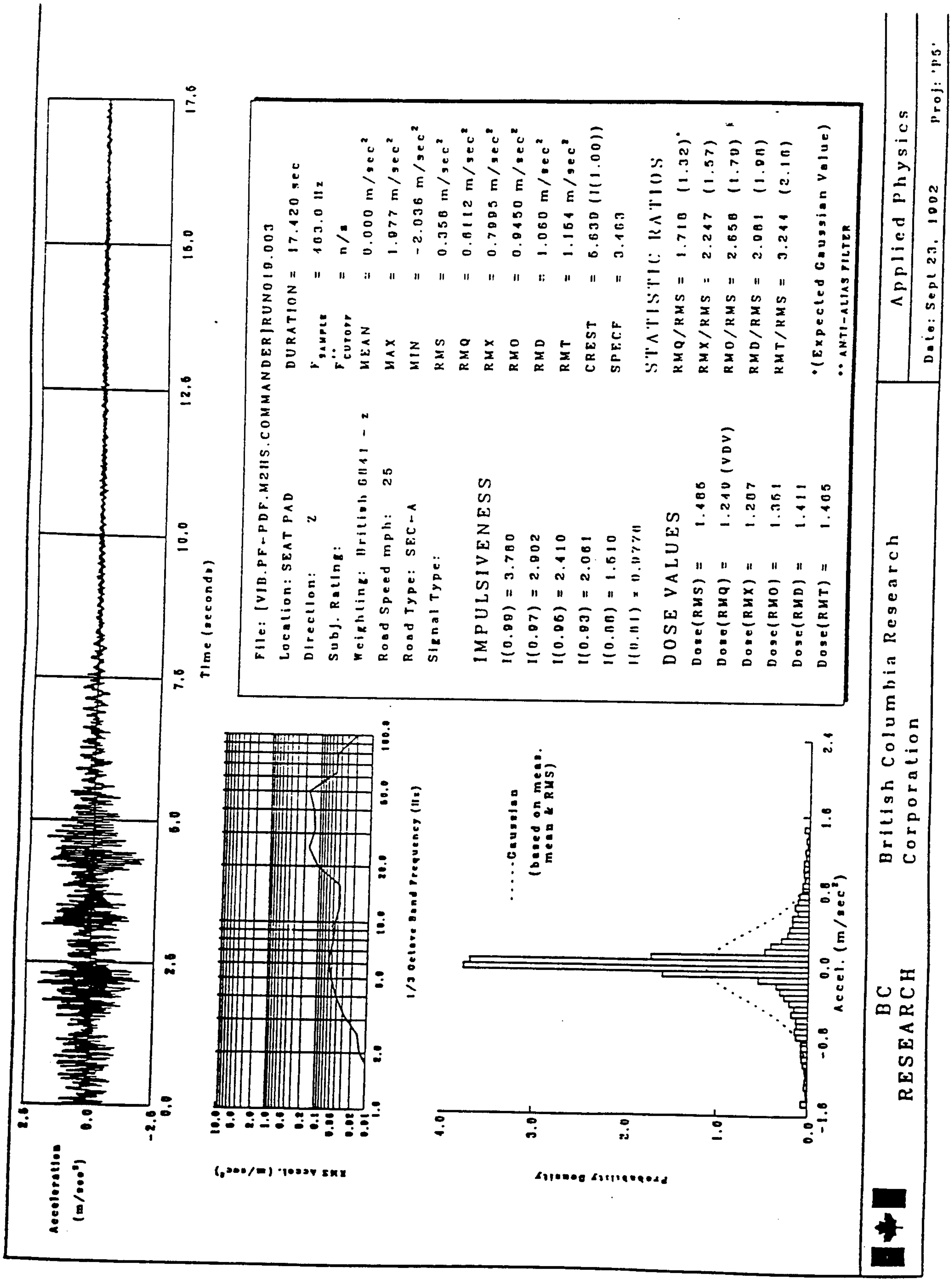


Figure 14
Seat motion analyzed using frequency weighting in British standard, BS 6841 (1987). Signal type 3: Transient random motion

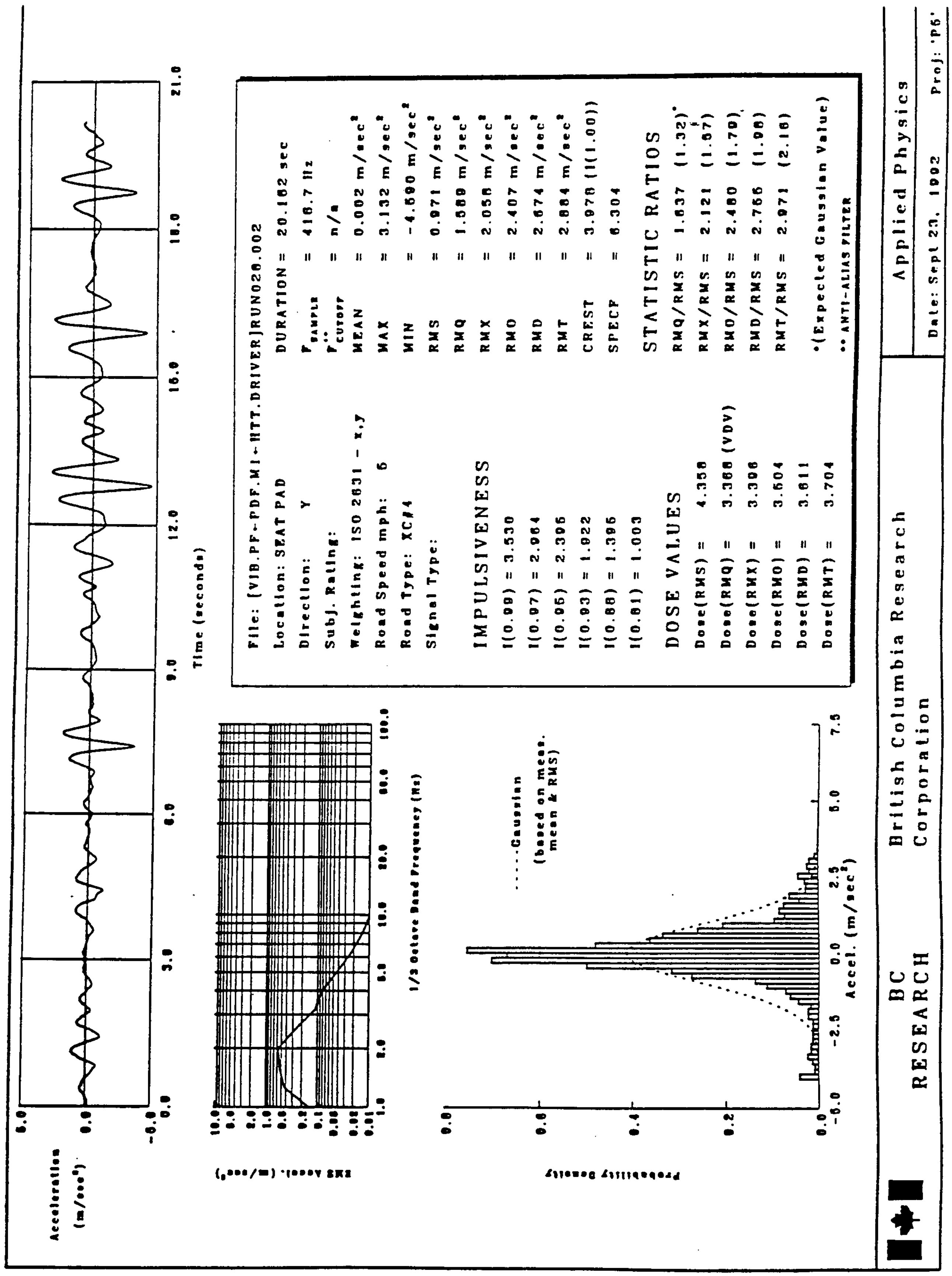


Figure 15
Seat motion analyzed using frequency weighting in British standard, BS 6841 (1987).
Signal type 3: Transient sinusoidal motion

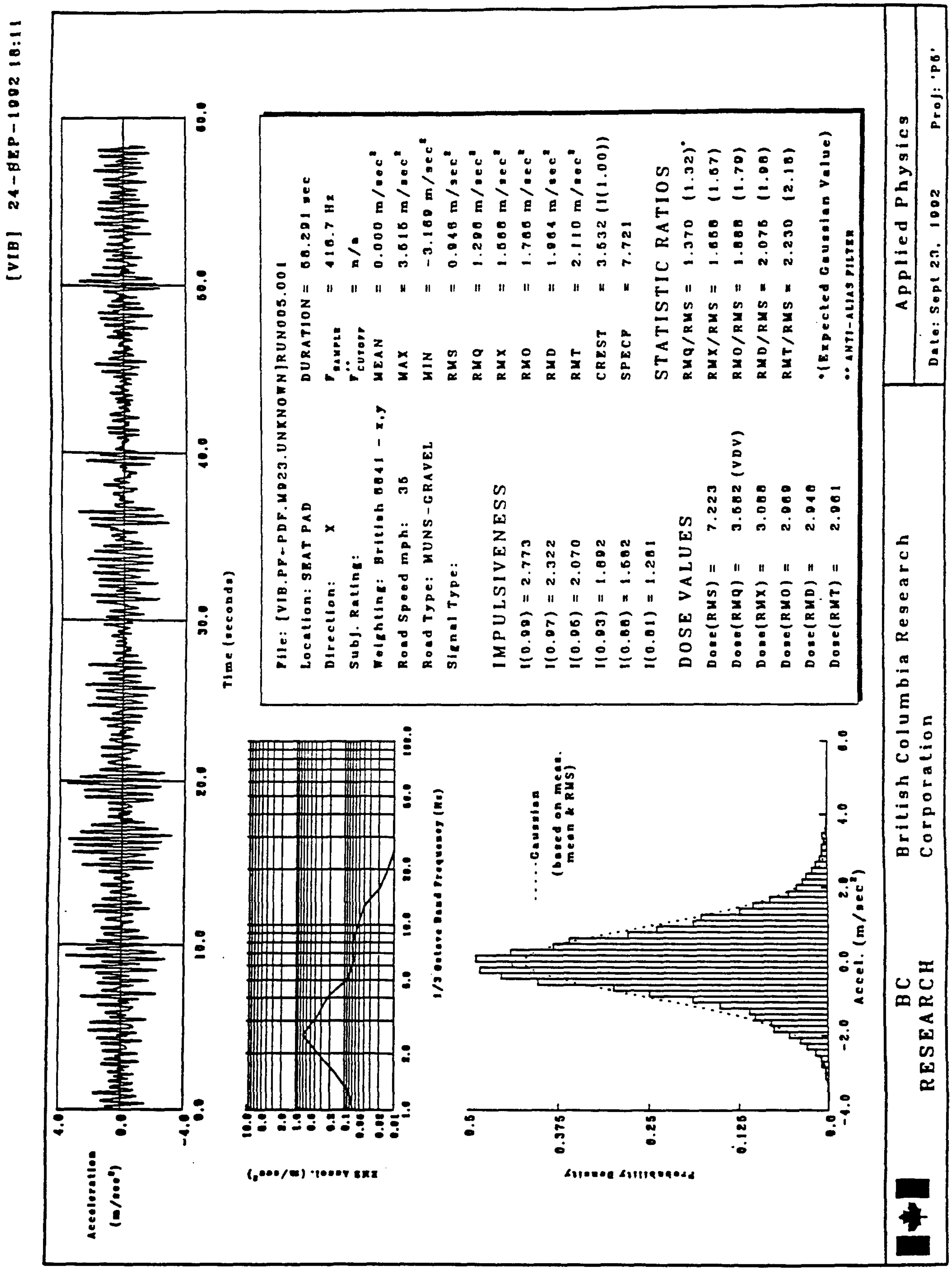


Figure 16
Seat motion analyzed using frequency weighting in British standard, BS 6841 (1987). Signal type 2: Amplitude-modulated near-sinusoidal motion

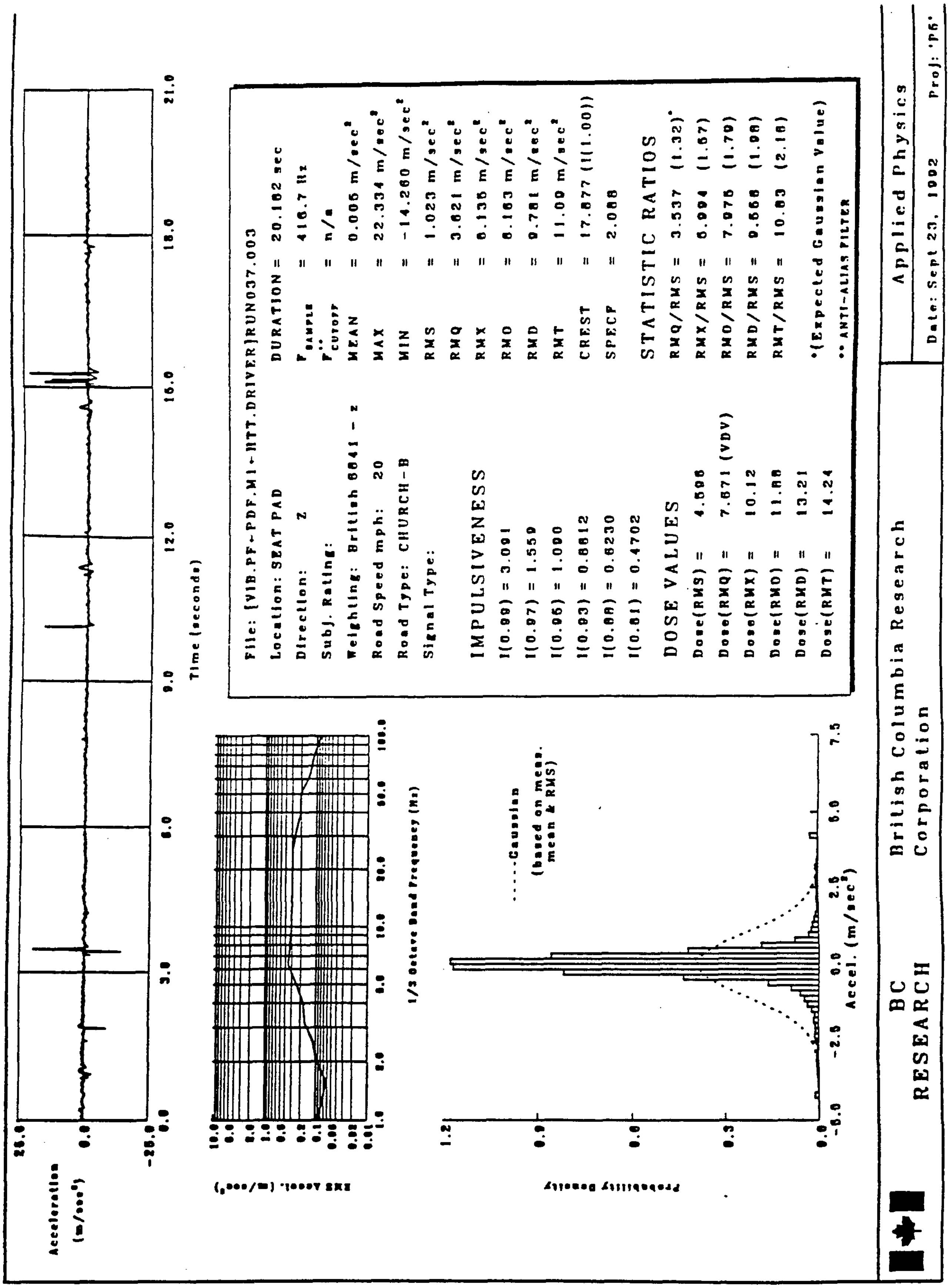


Figure 17
Seat motion analyzed using frequency weighting in British standard, BS 6841 (1987). Signal type 4: Impulses (shocks)

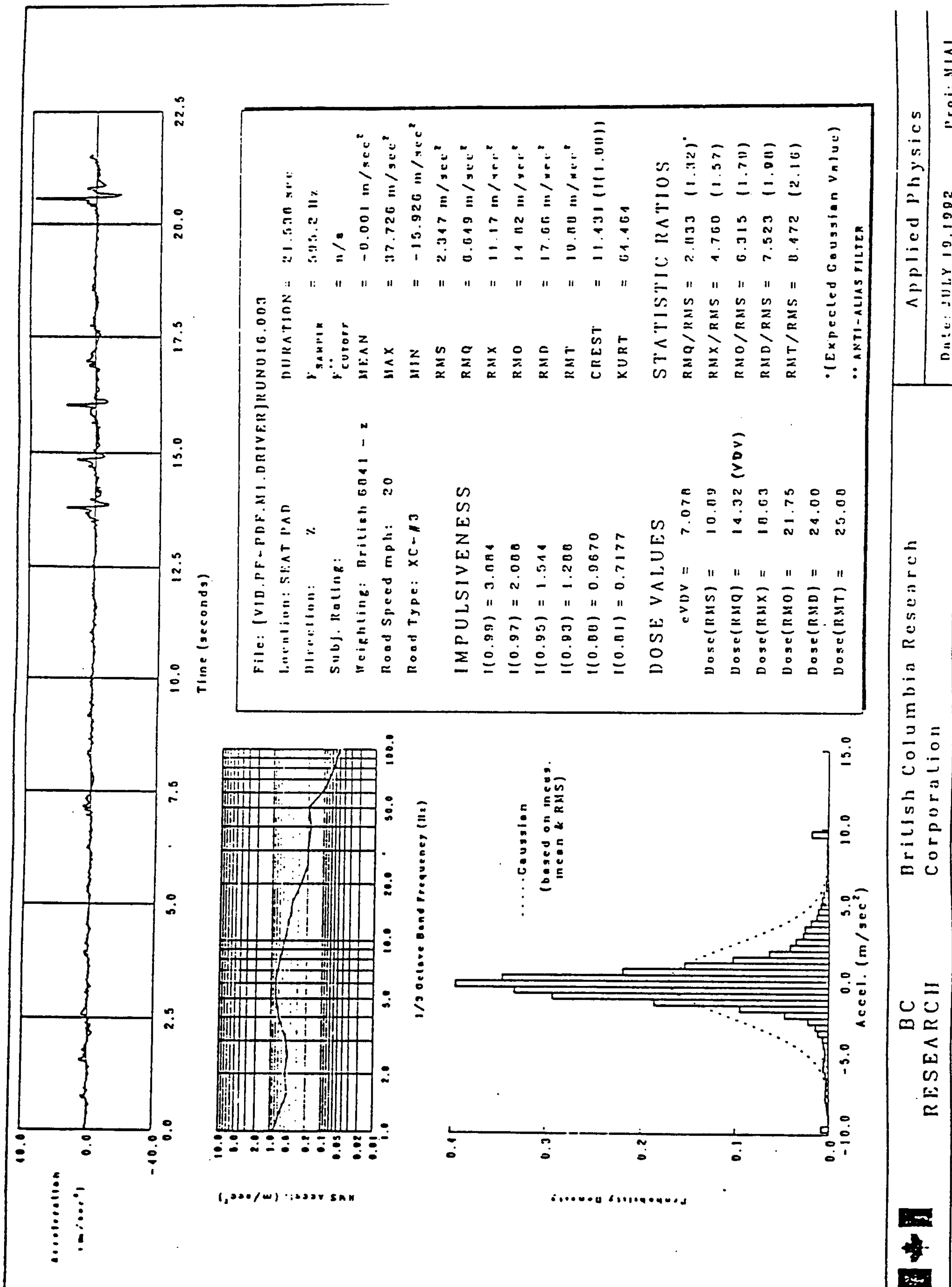


Figure 18
Seat motion analyzed using frequency weighting in British standard, BS 6841 (1987). Signal type 4: Impulses (shocks)

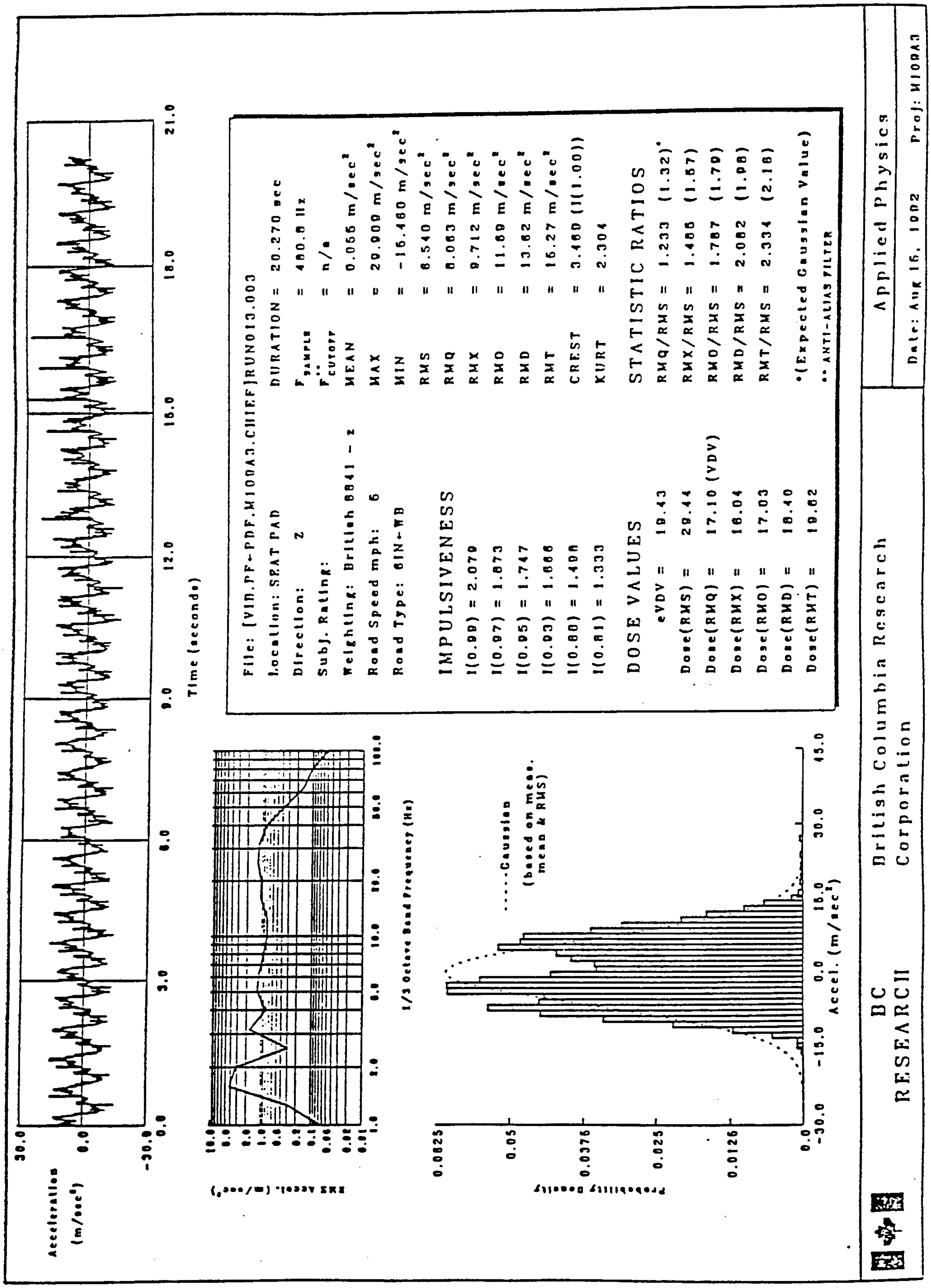


Figure 19
Seat motion analyzed using frequency weighting in British standard, BS 6841 (1987).
Signal type 2: Oscillatory motion with impulses (shocks)

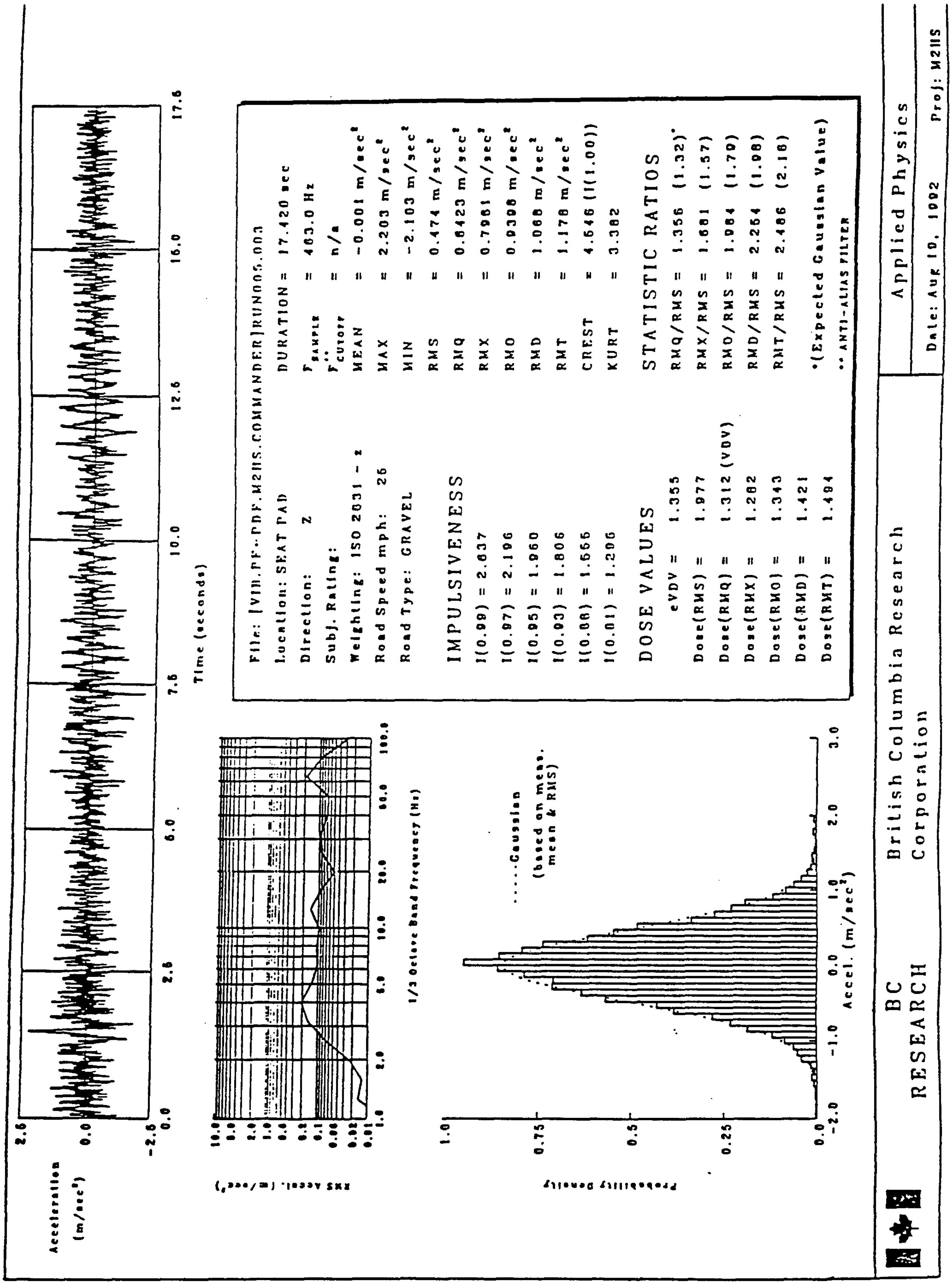


Figure 20
Seat motion analyzed using frequency weighting in the ISO standard, ISO 2631 (1985). Signal type 1: Gaussian random motion

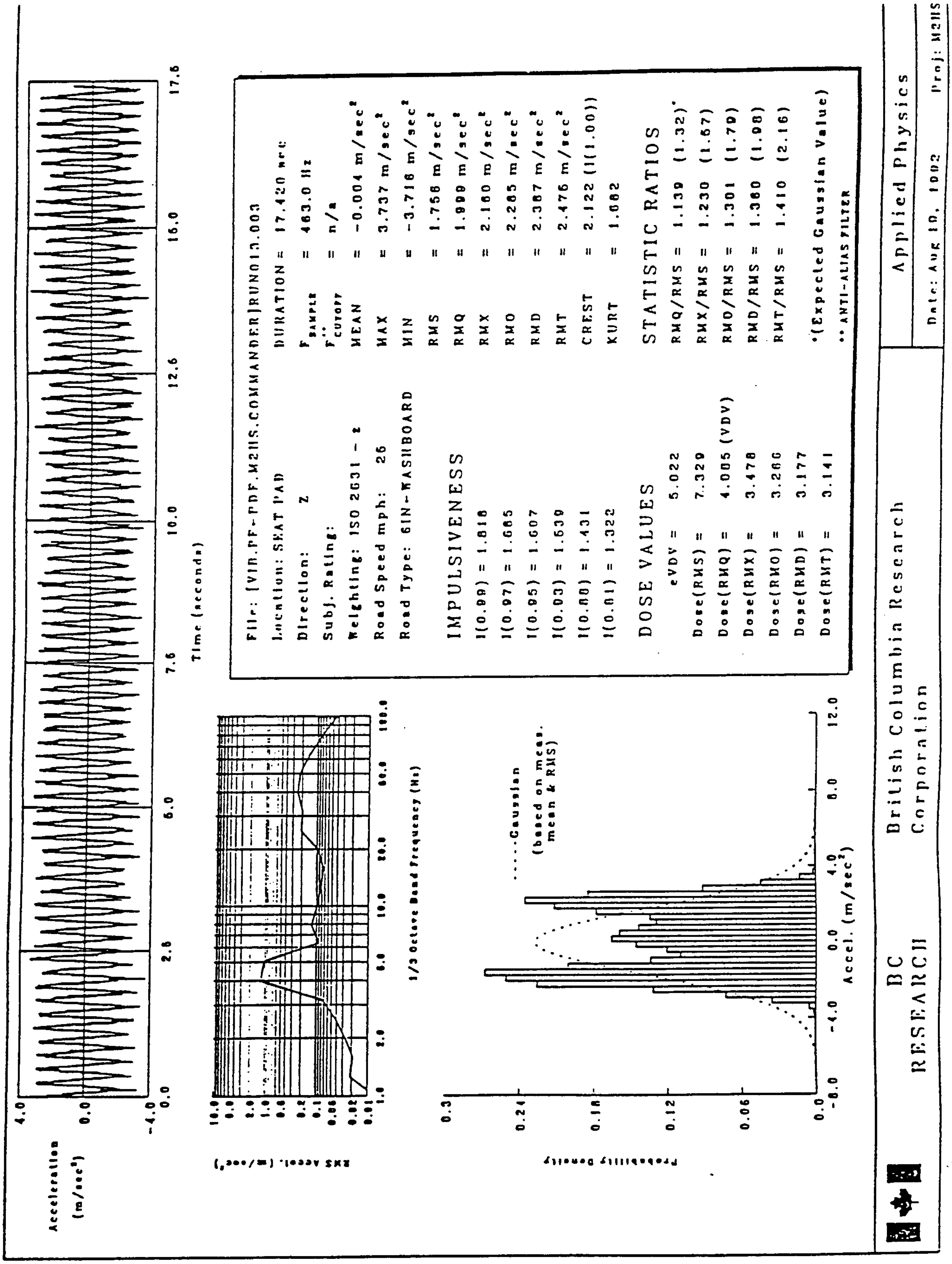


Figure 21
Seat motion analyzed using frequency weighting in the ISO standard, ISO 2631 (1985). Signal type 2: Near sinusoidal motion

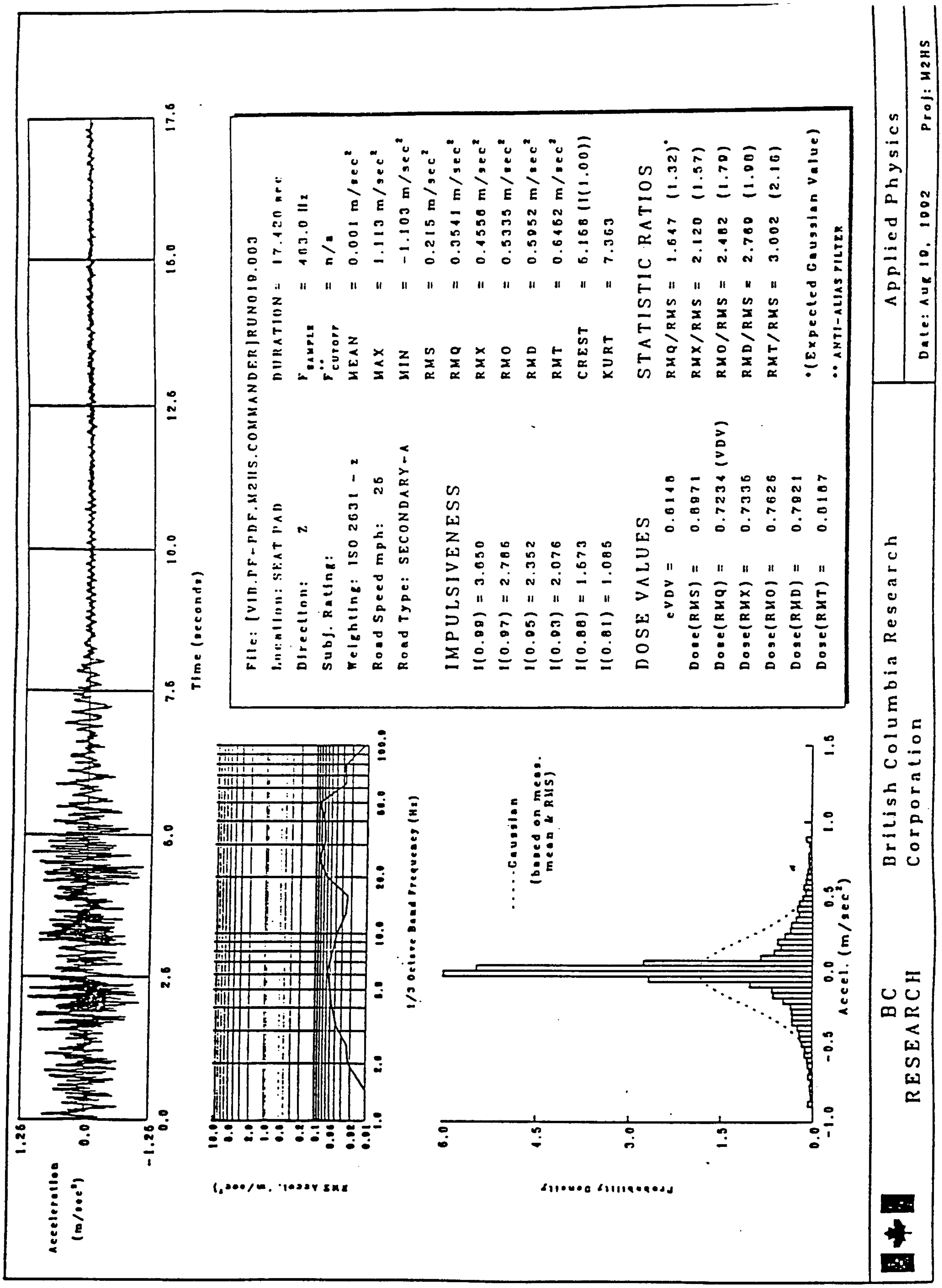


Figure 22
Seat motion analyzed using frequency weighting in the ISO standard, ISO 2631 (1985). Signal type 3: Transient random motion

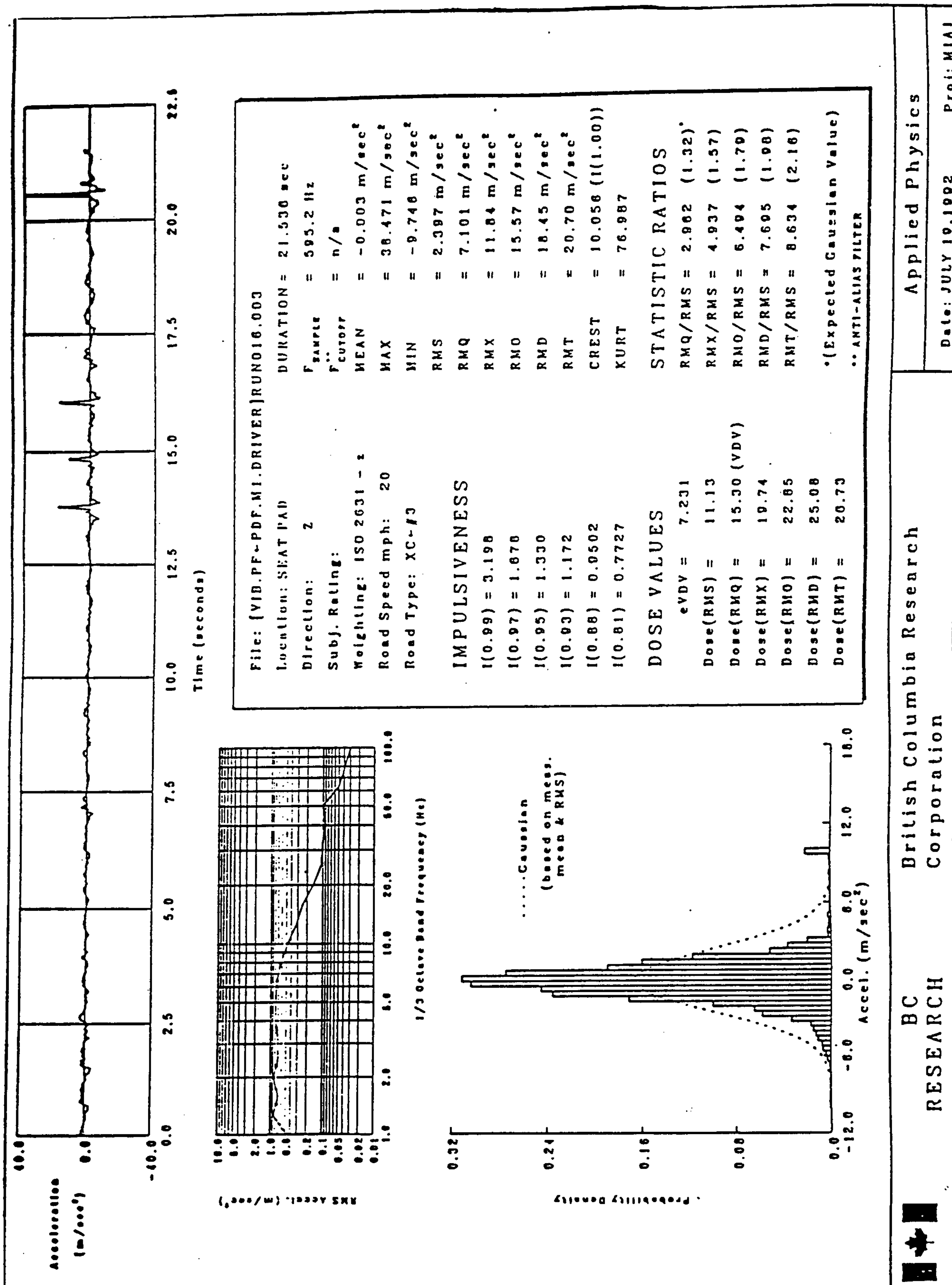


Figure 23
Seat motion analyzed using frequency weighting in the ISO standard, ISO 2631 (1985). Signal type 4: Impulses (shocks)

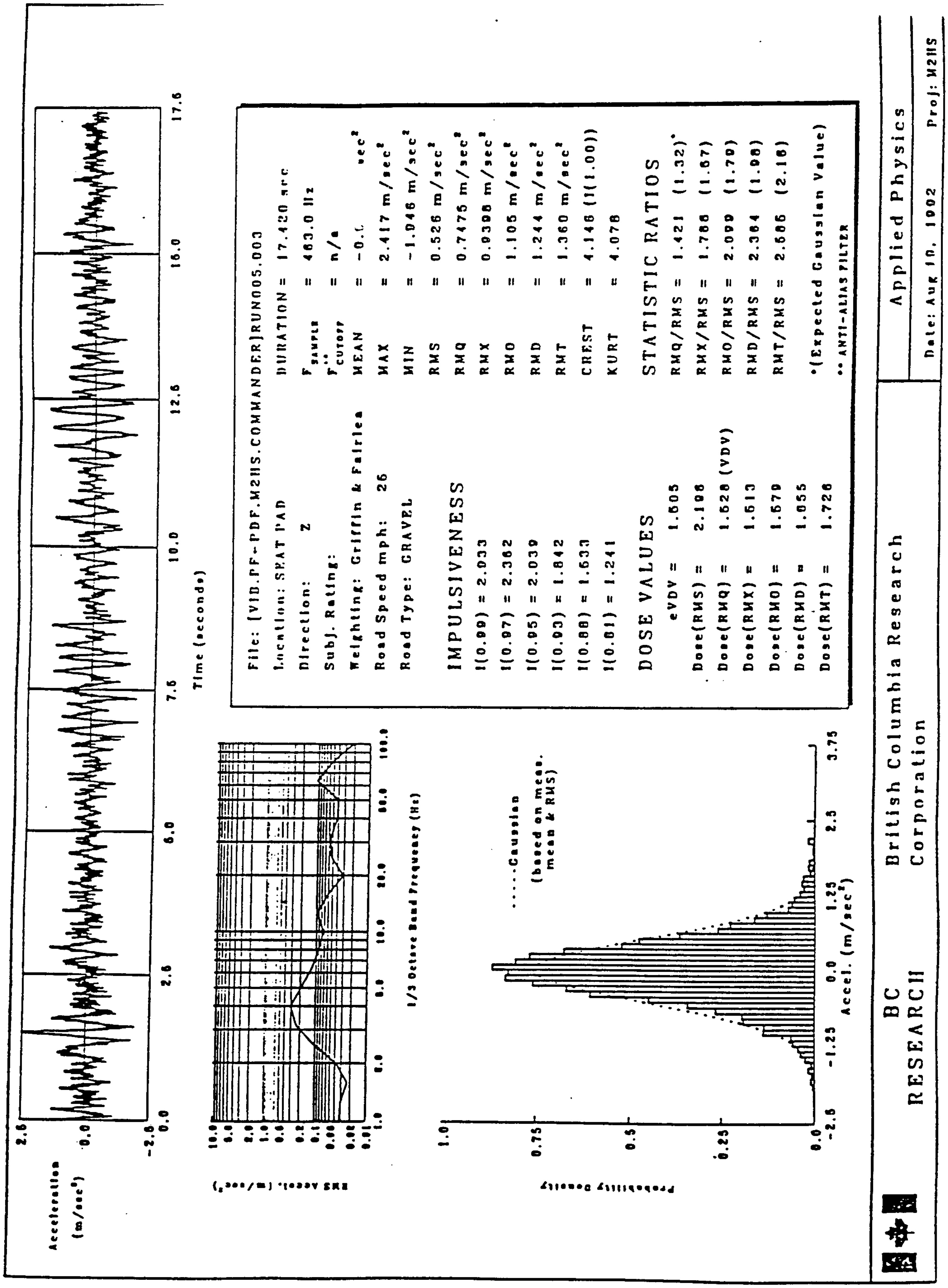


Figure 24
Seat motion analyzed using Fairley-Griffin biodynamic model.
- Signal type 1: Gaussian random motion

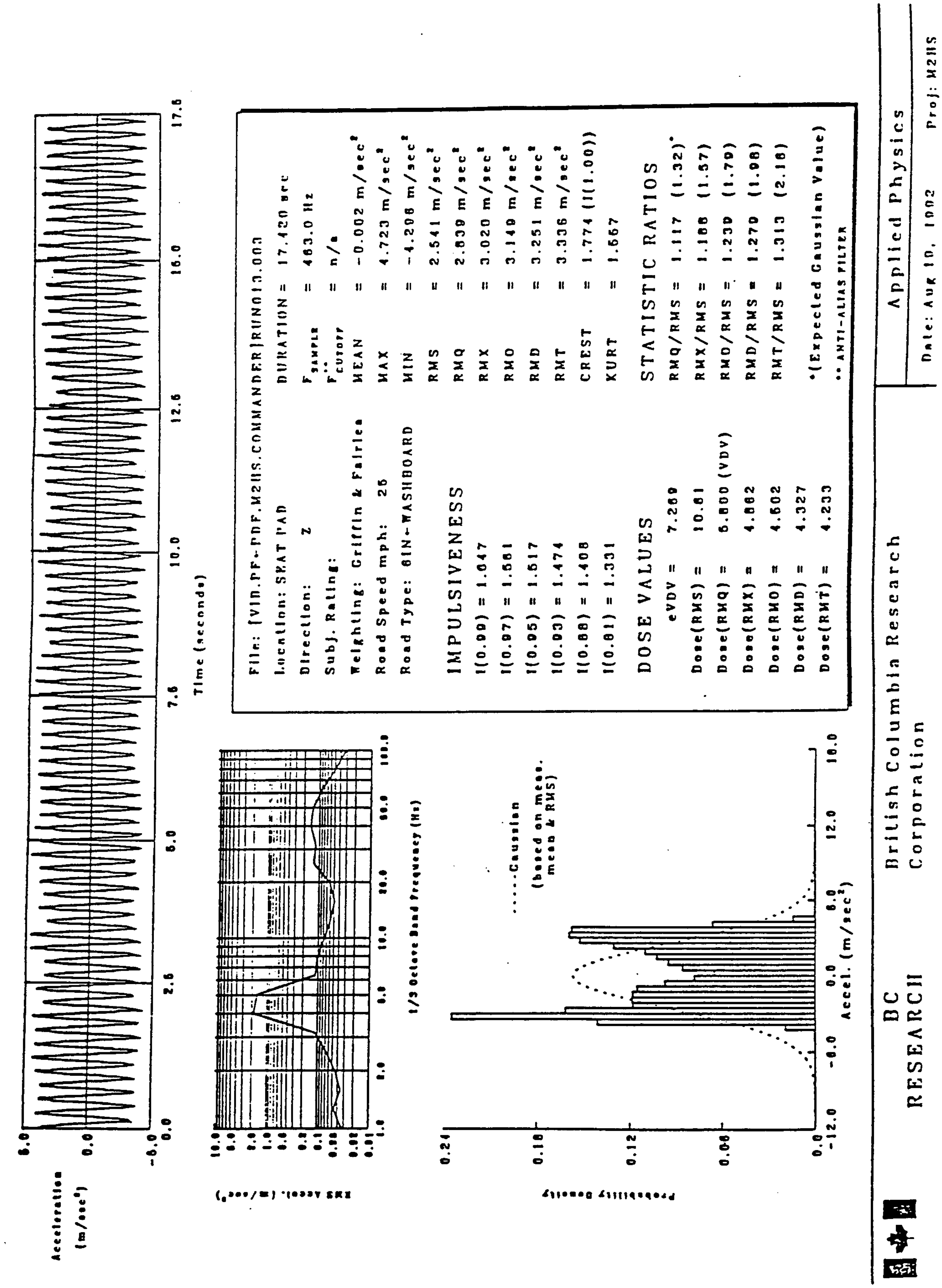


Figure 25
Seat motion analyzed using Fairley-Griffin biodynamic model.
Signal type 2: Near sinusoidal motion

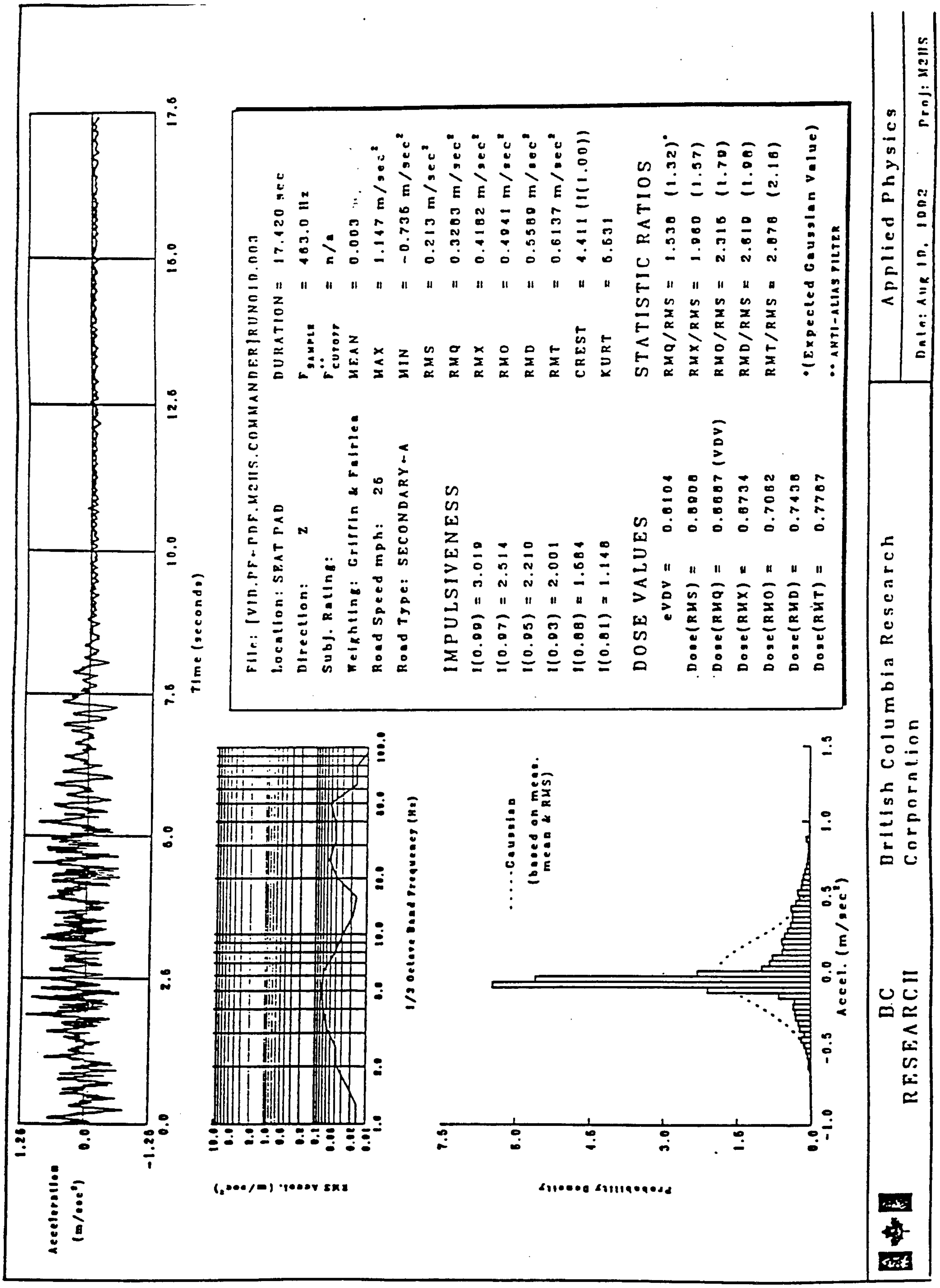


Figure 26
Seat motion analyzed using Fairley-Griffin biodynamic model.
- Signal type 3: Transient random motion

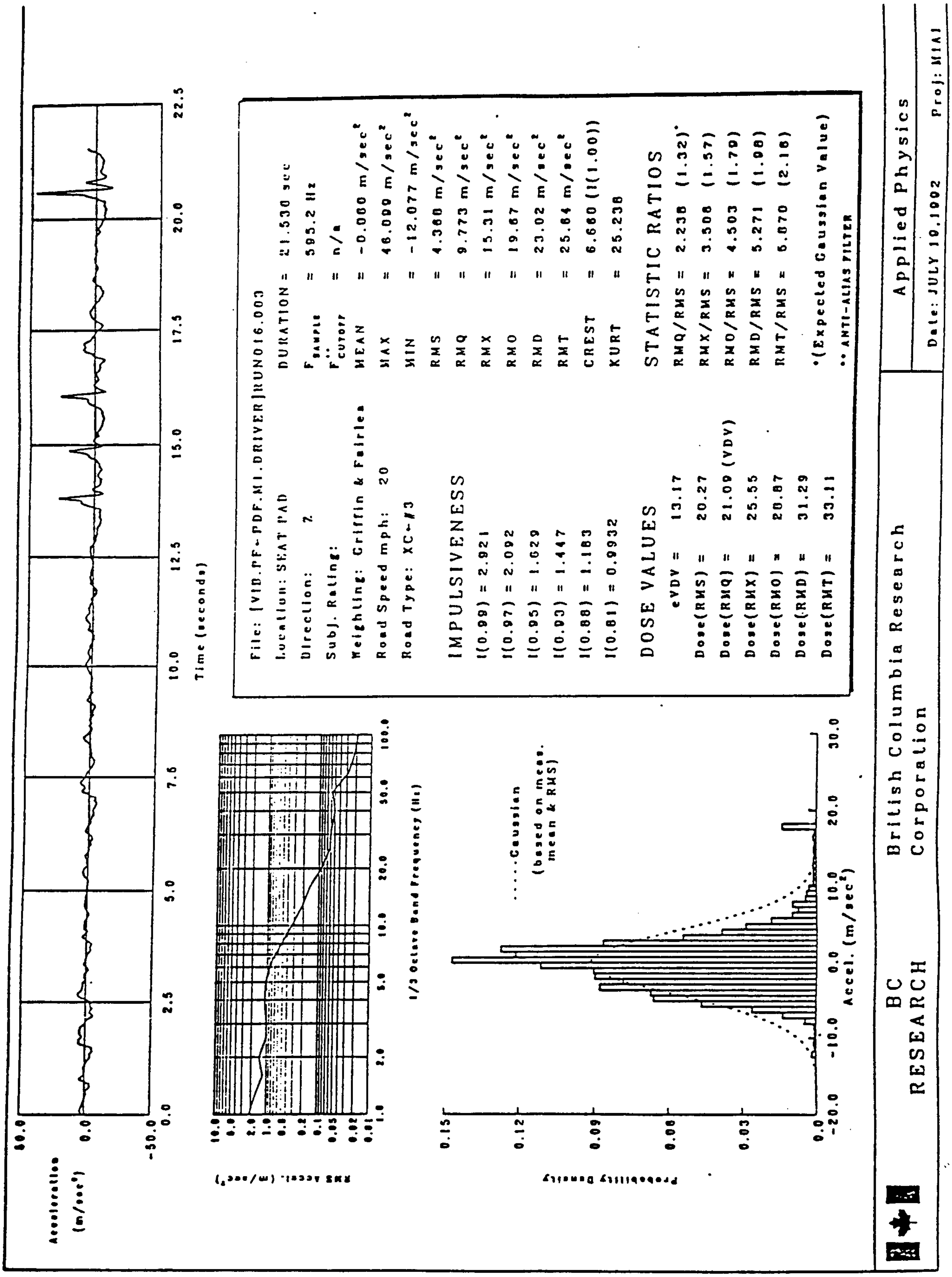


Figure 27
Seat motion analyzed using Fairley-Griffin biodynamic model (Table 2). Signal type 4: Impulses (shocks)

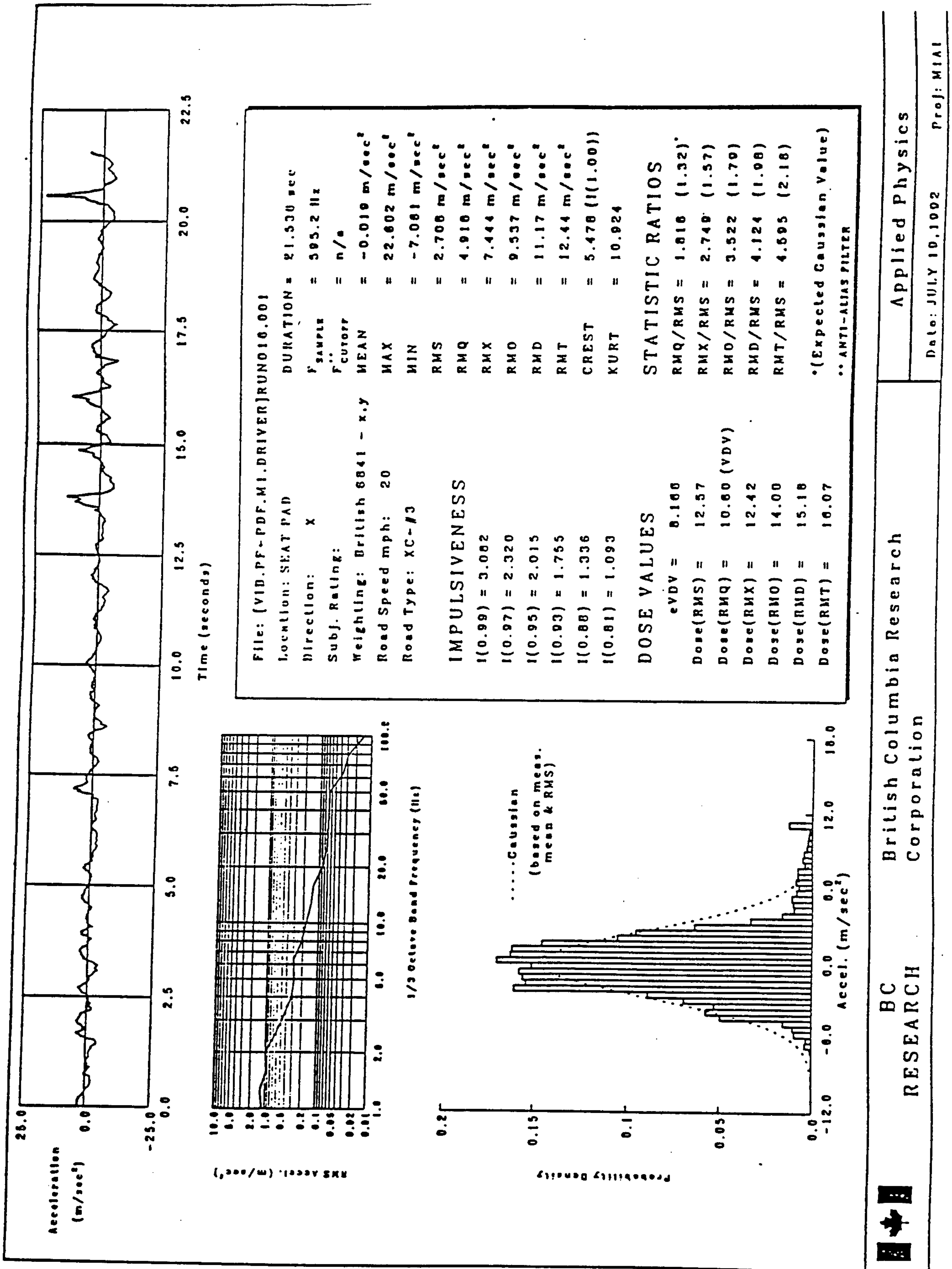


Figure 28
Seat motion containing impulses (shocks) analyzed using frequency weighting in British standard, BS 6841 (1987) during cross-country operation of M1A1 (X direction).

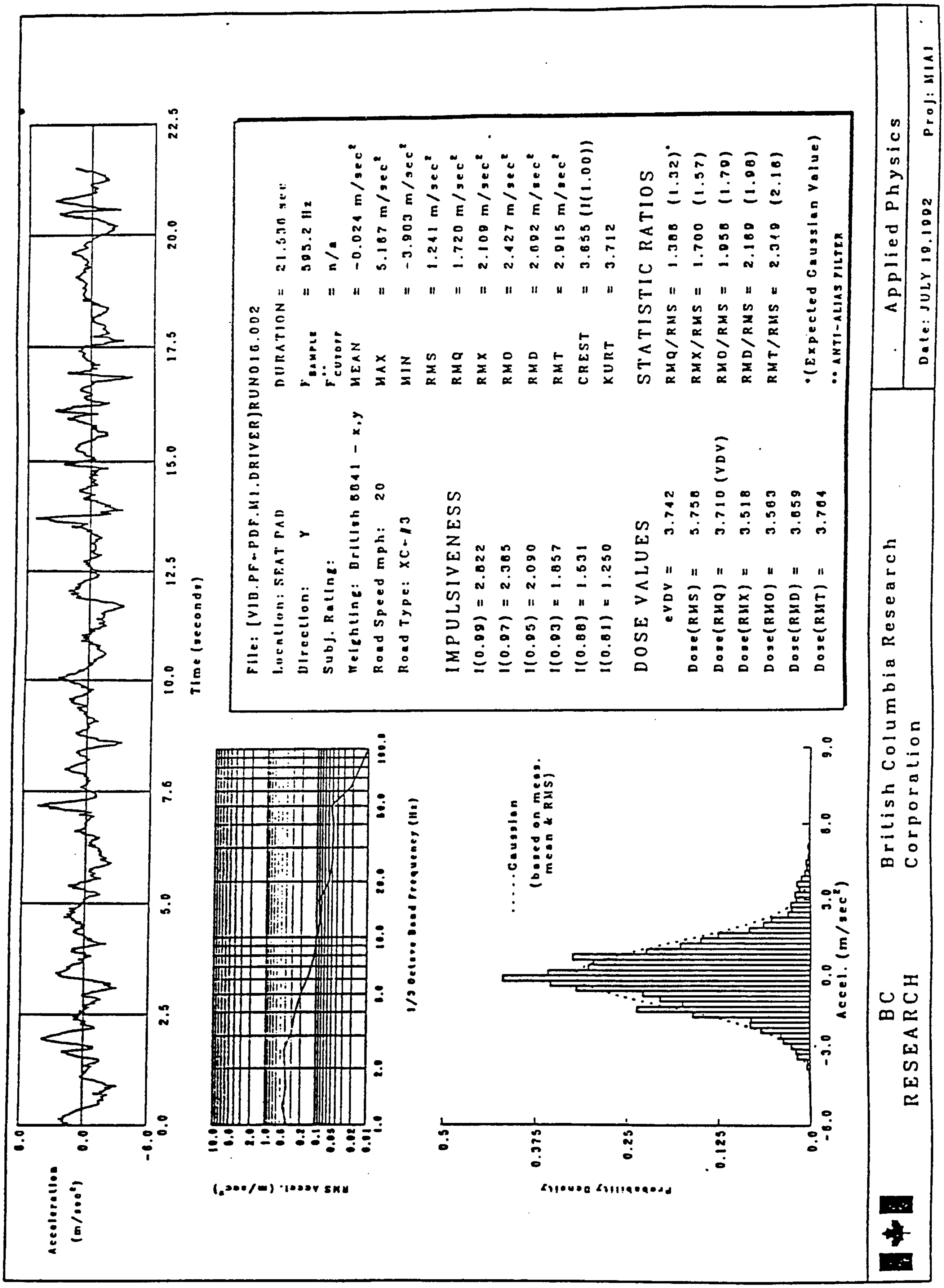


Figure 29
Seat motion containing impulses (shocks) analyzed using frequency weighting in British standard, BS 6841 (1987) during cross-country operation of M1A1 (Y direction).

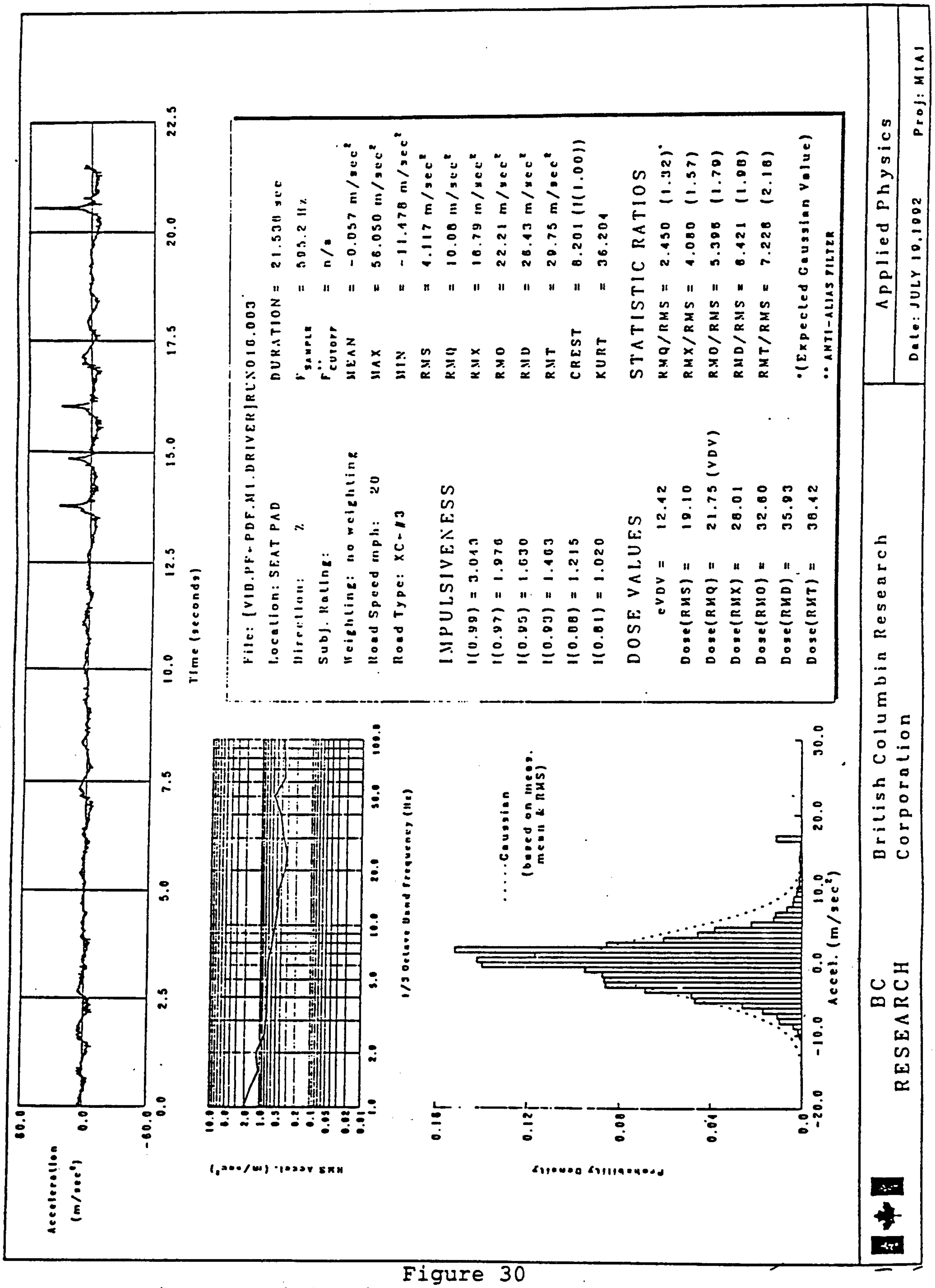


Figure 30
Seat motion containing impulses (shocks) during cross-country operation of M1A1 (Z direction - no frequency weighting).

1. MINIMUM AMPLITUDE: 1.0 G
2. MINIMUM (TIME) SEPARATION: 0.25 SEC
3. TYPES:

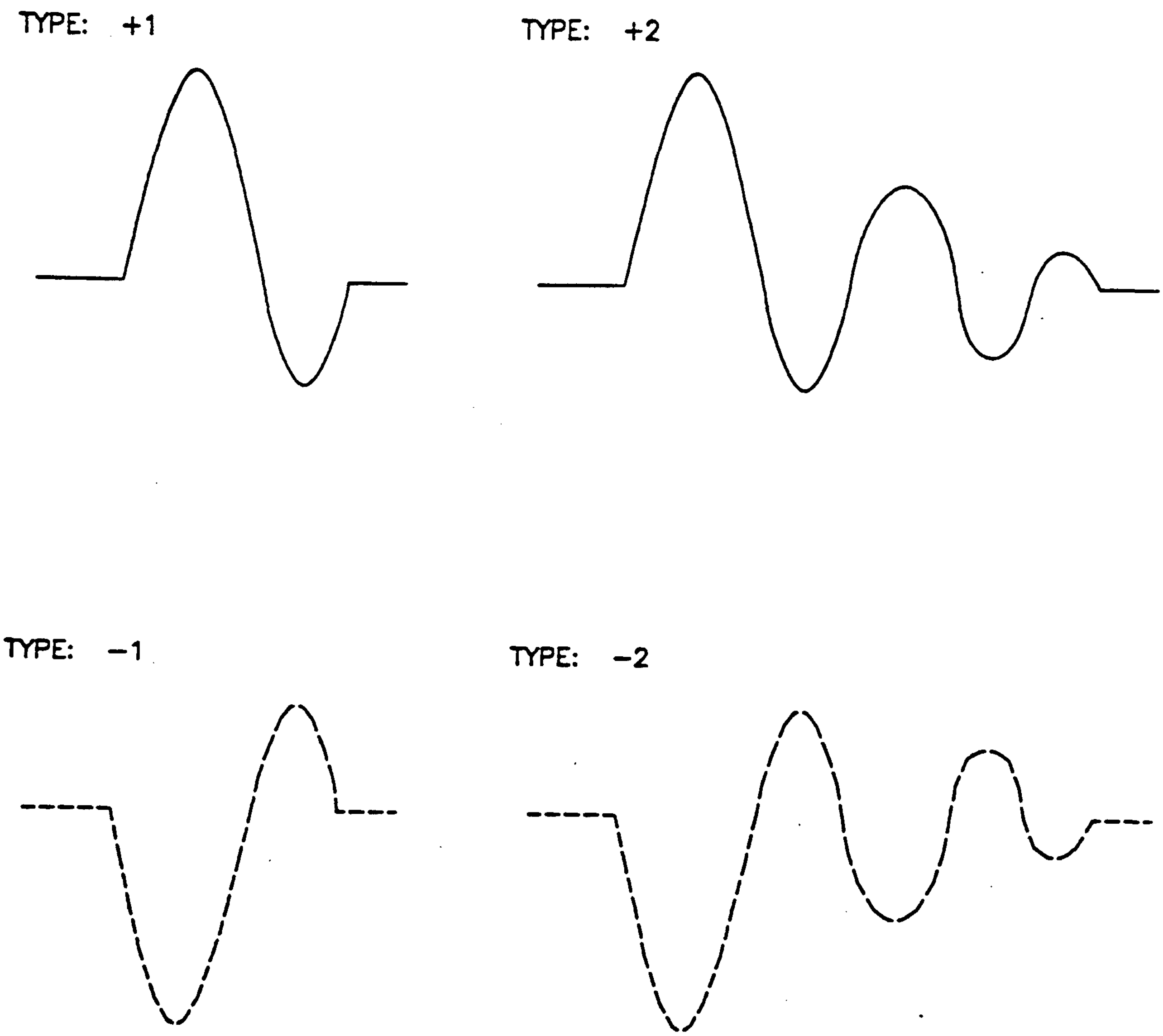


Figure 31
Definition of shocks

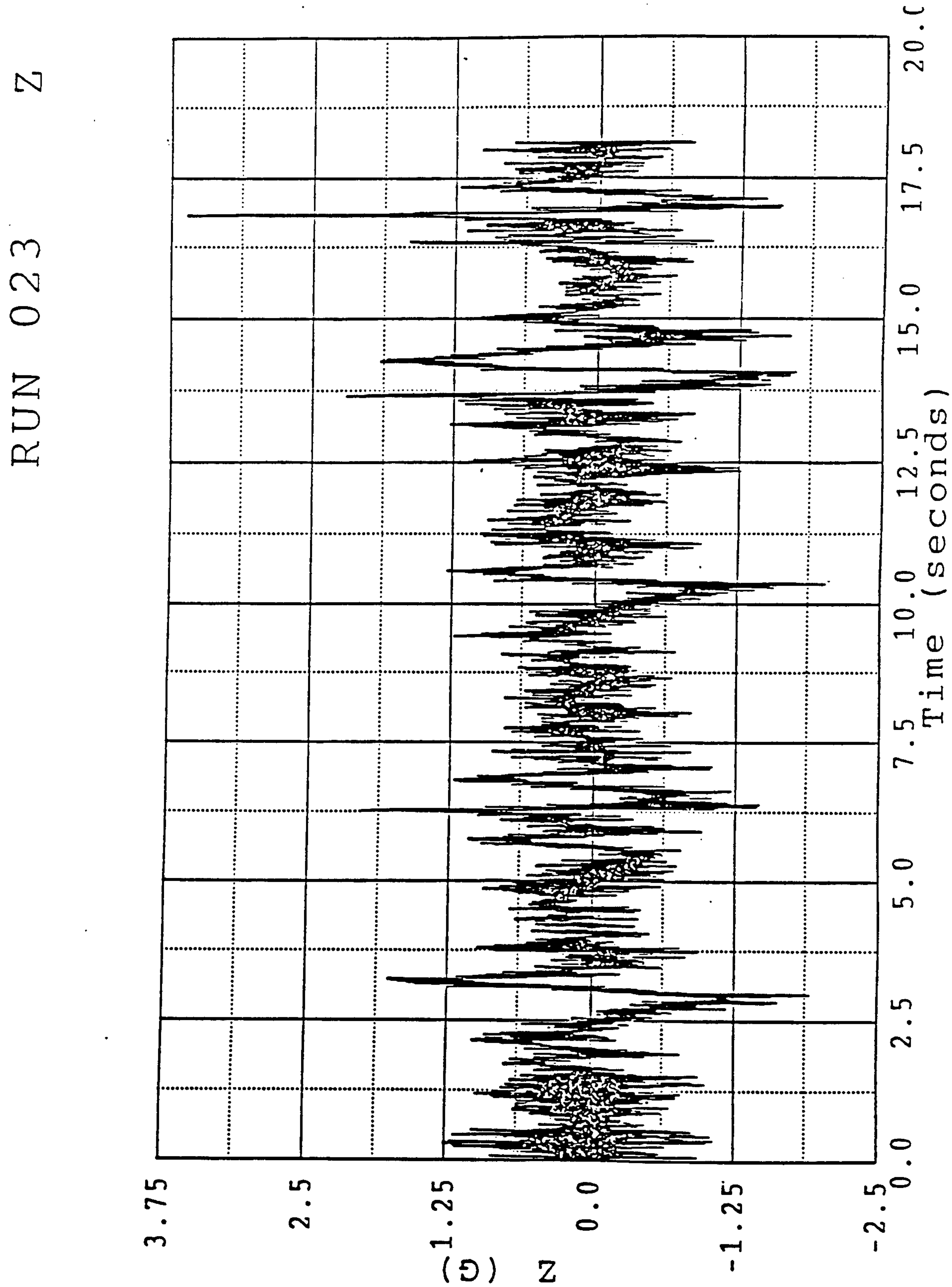


Figure 32
Seat motion waveform, containing shocks, during cross-country operation of M2HS Bradley

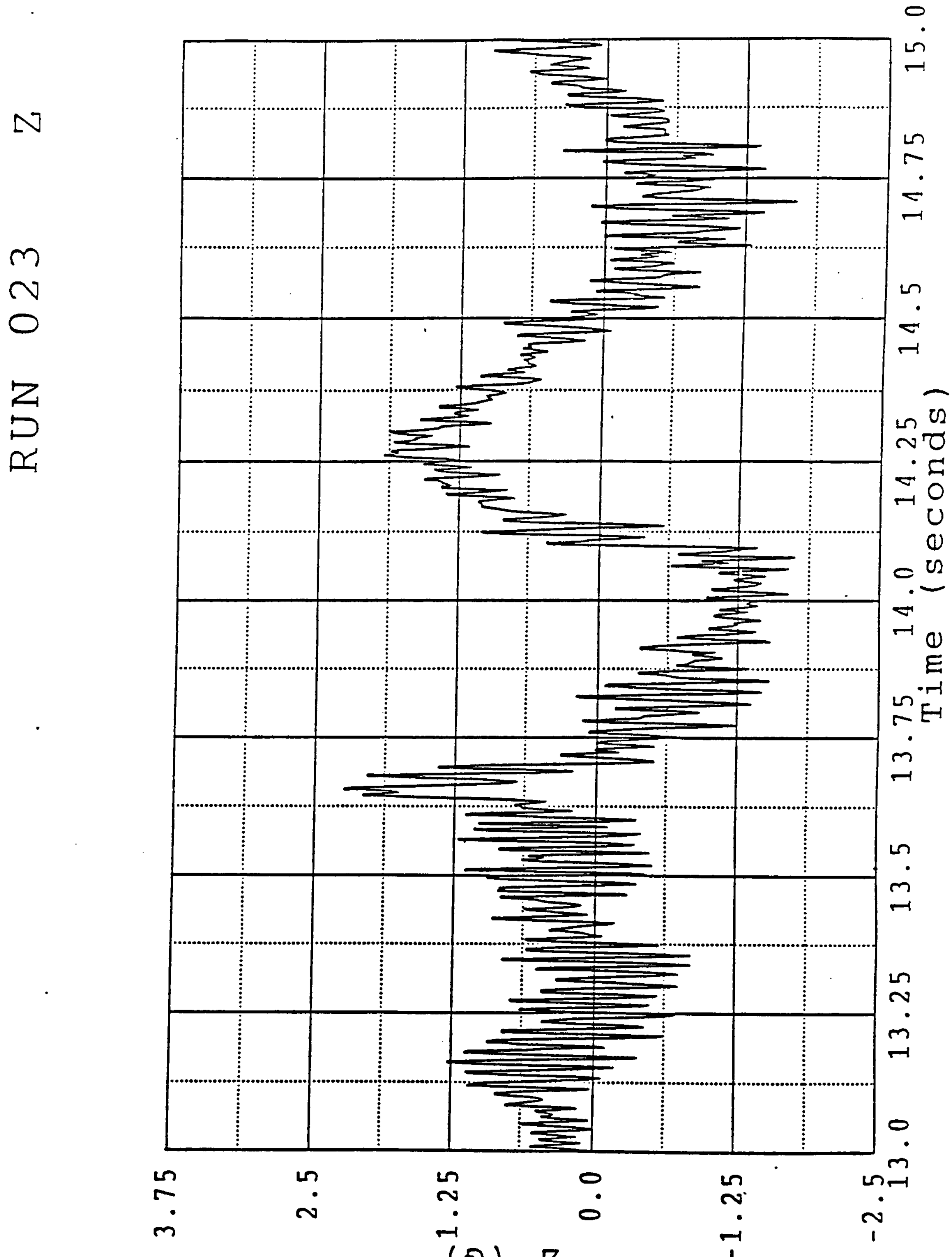


Figure 33
Detail from the seat motion waveform in Figure 29 showing shock event #4.

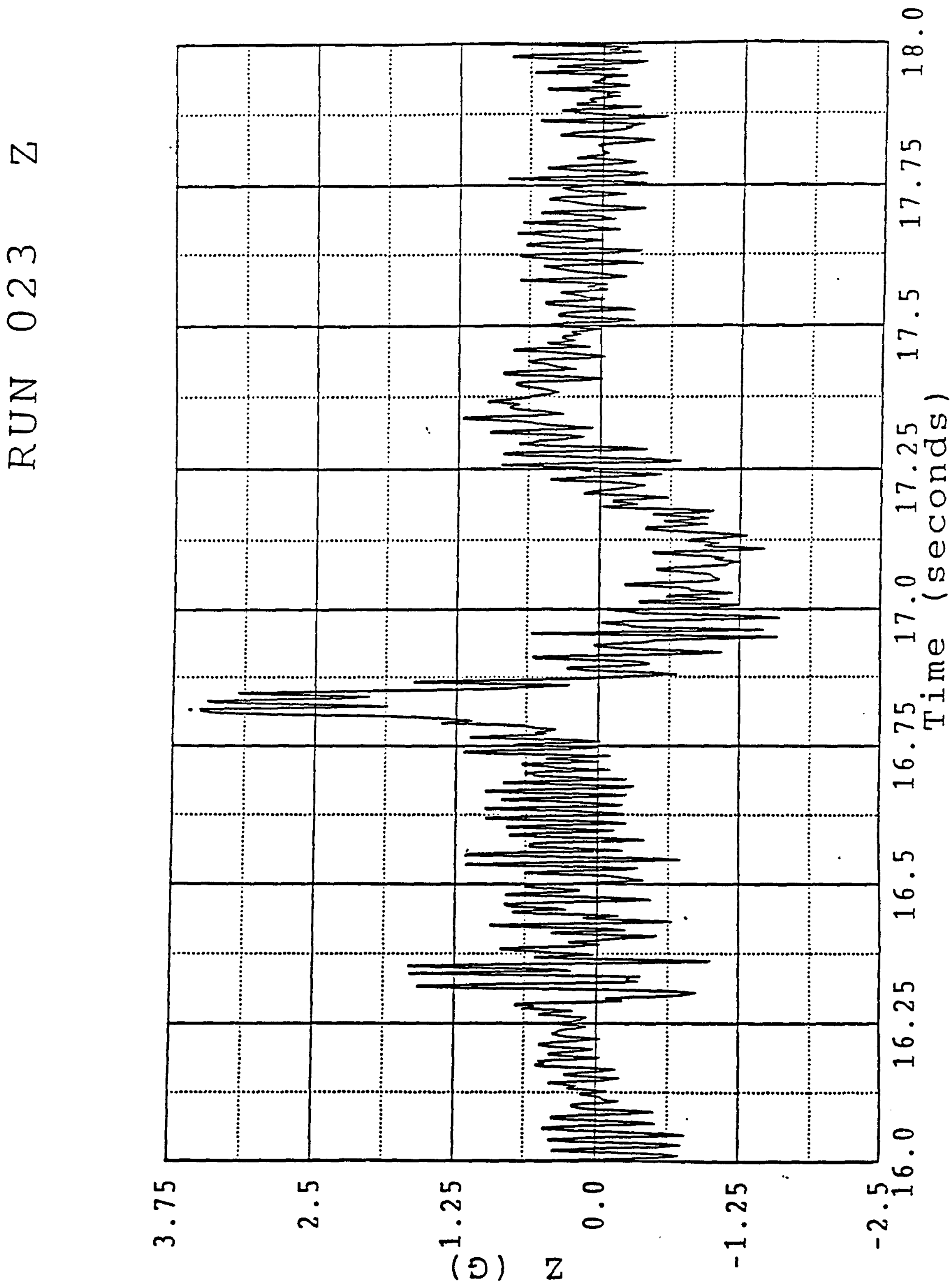


Figure 34
Detail from the seat motion waveform in
Figure 29 showing shock event #5.

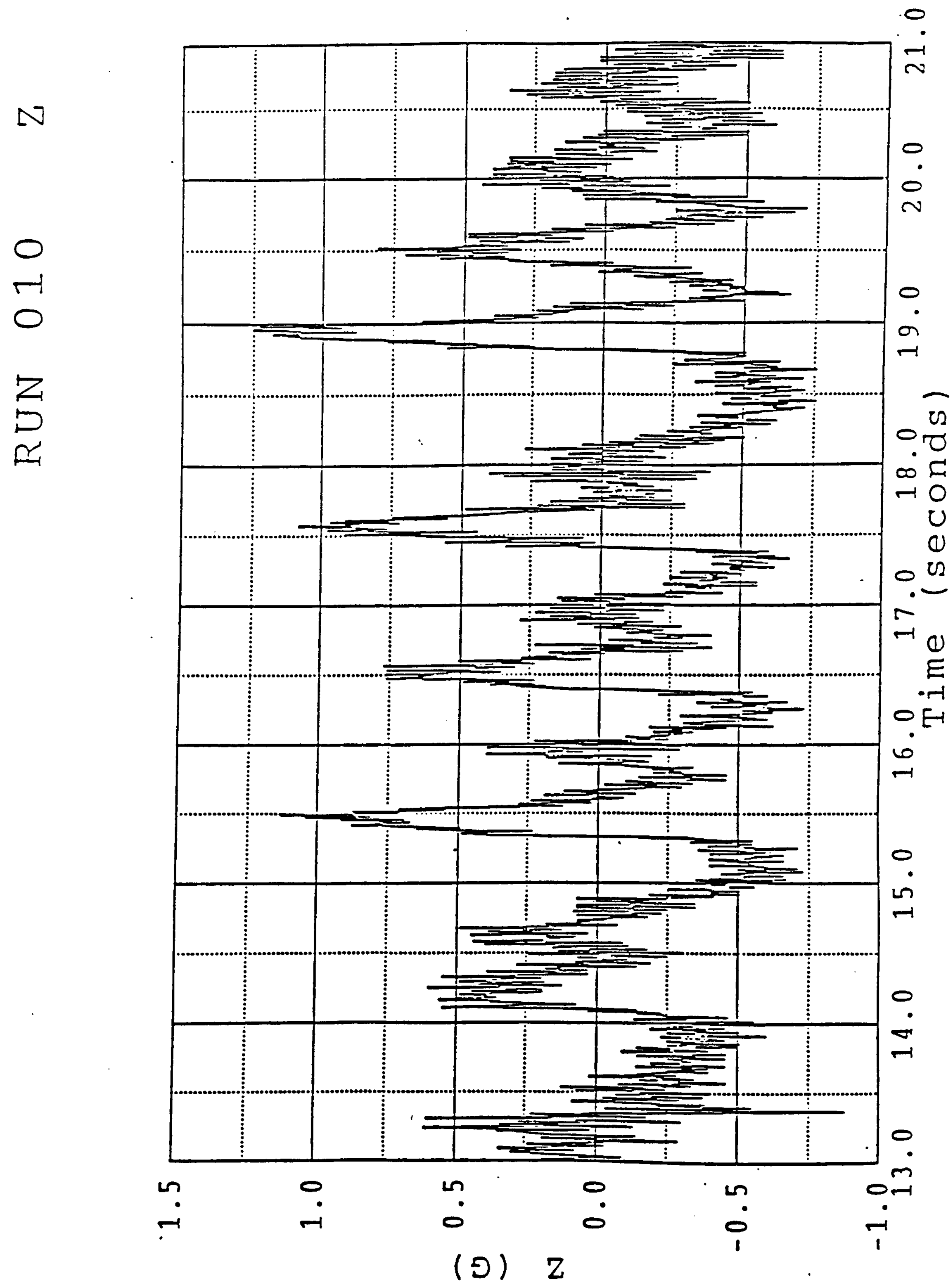


Figure 35
Seat motion waveform, containing repeated impacts, during cross-country operation of M109A3

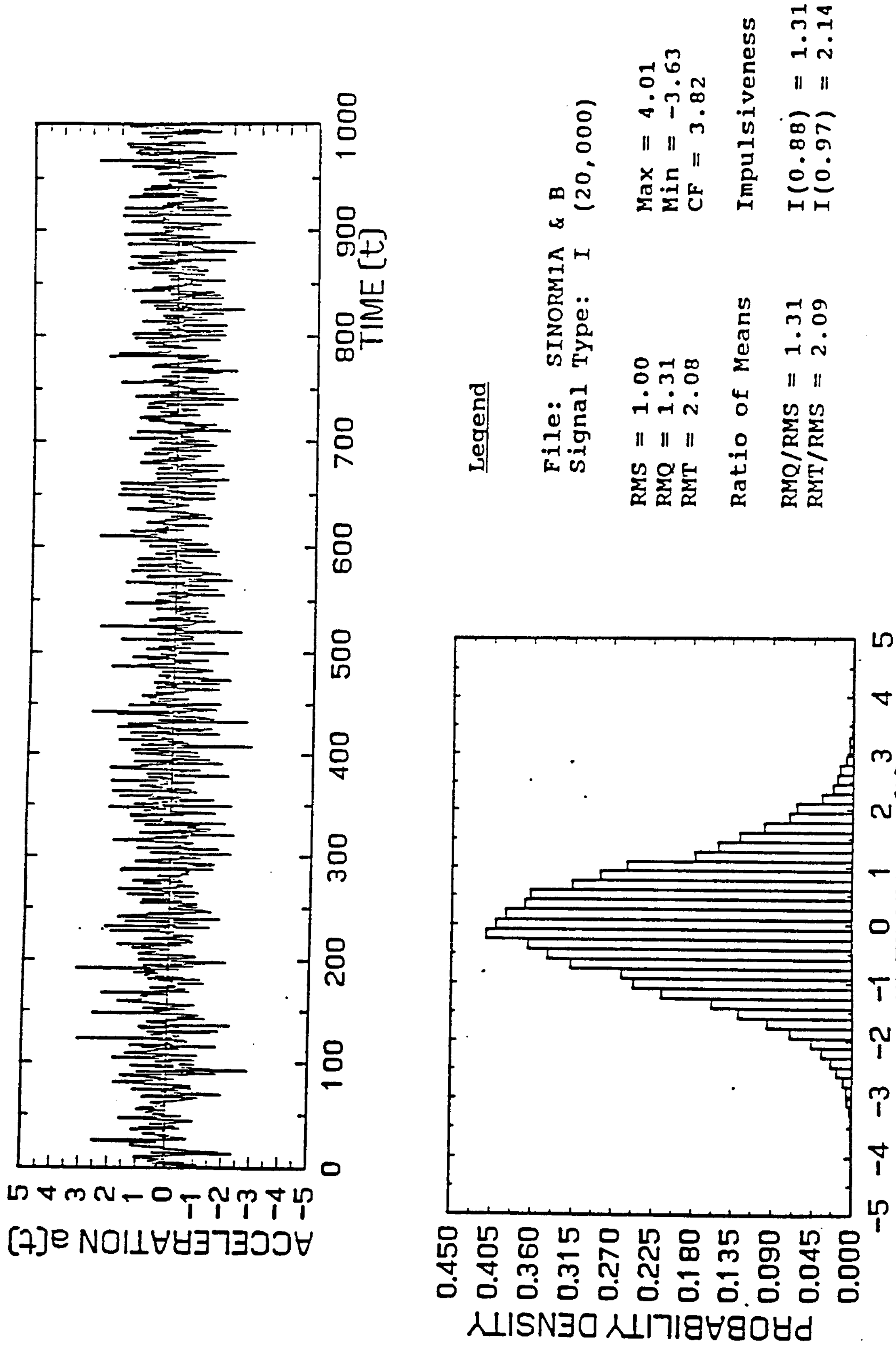


Figure 36
Simulated Gaussian random motion

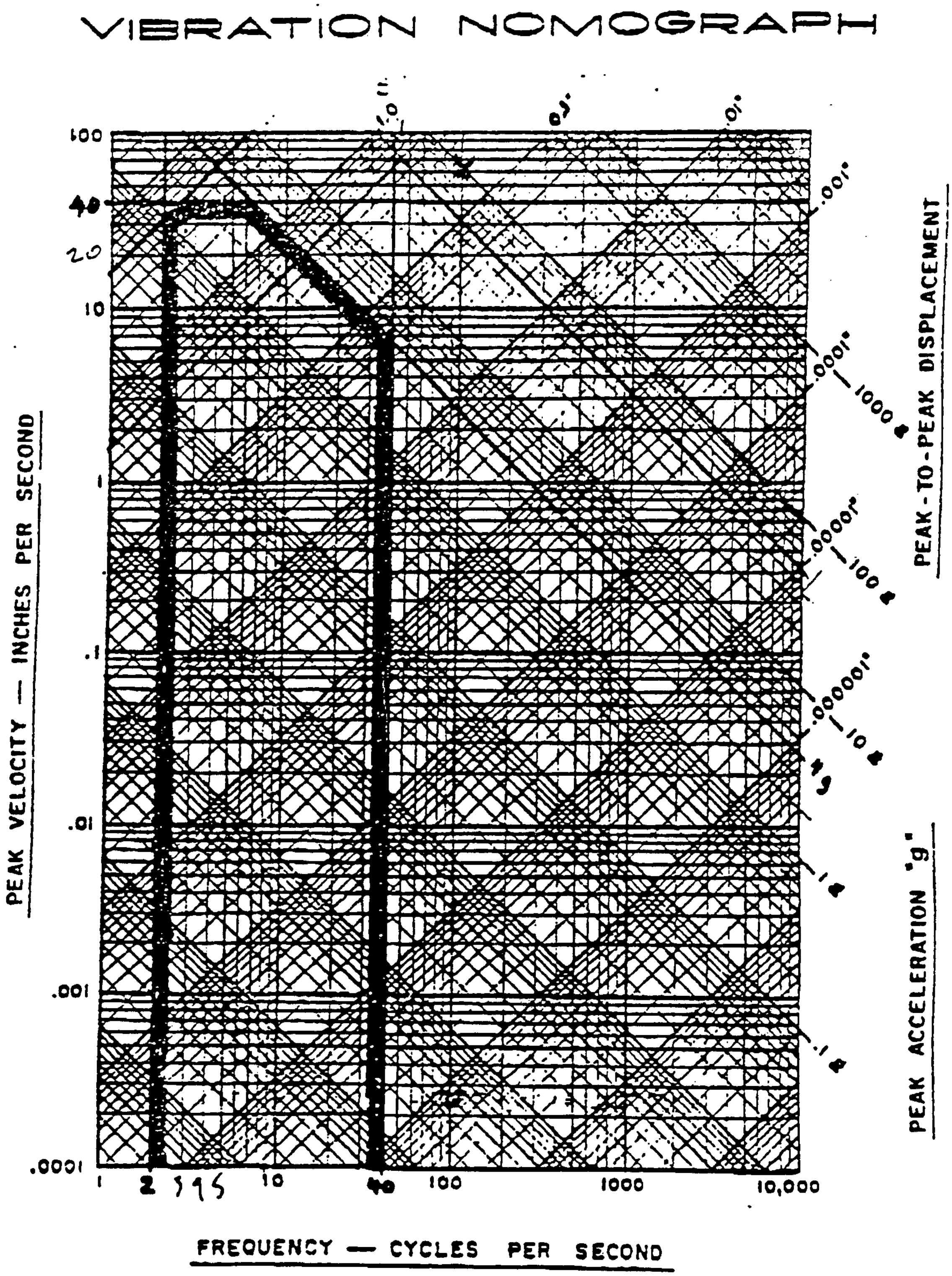


Figure 37
Limits of motion established for
subject safety at the MARS facility

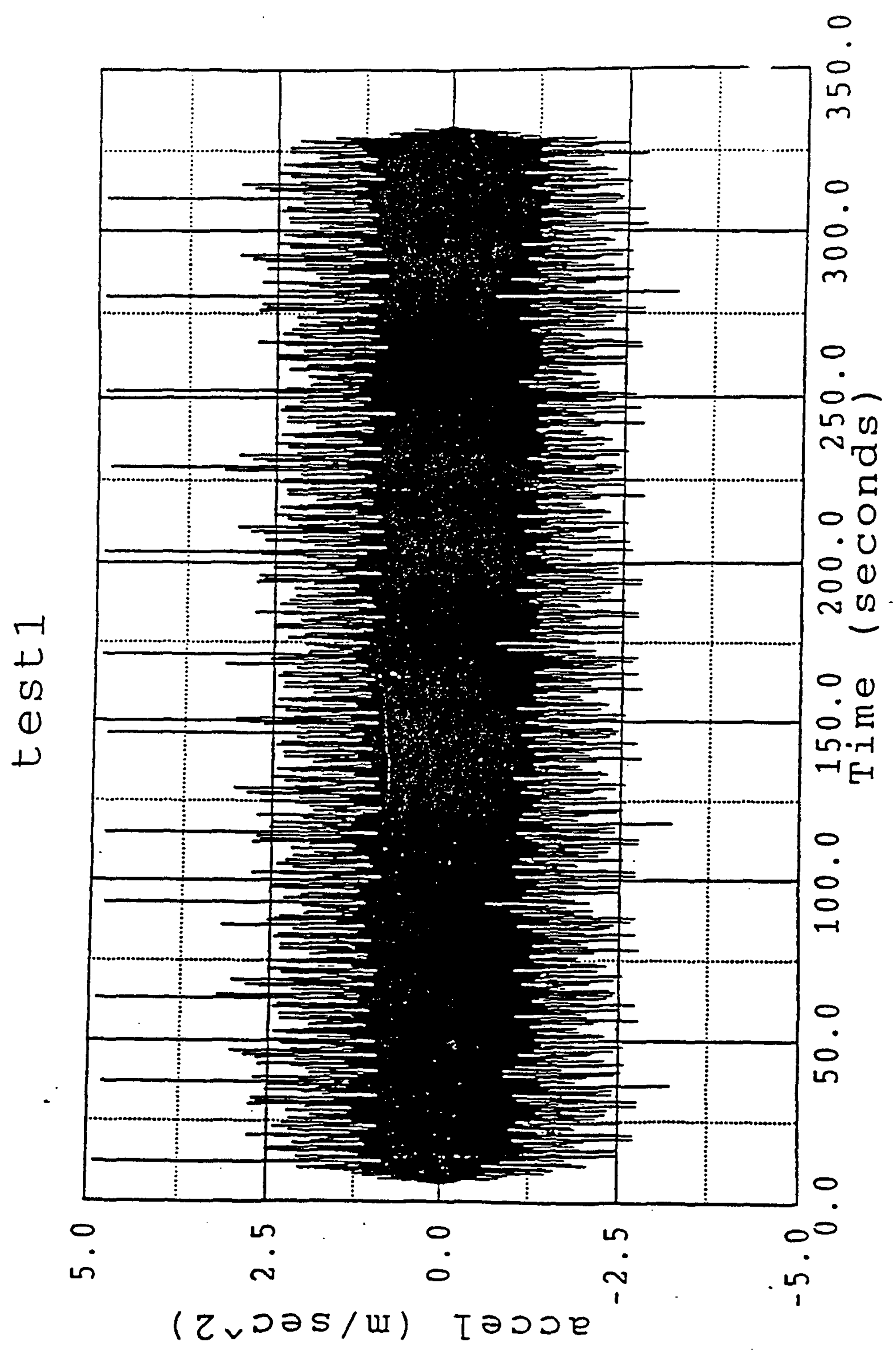


Figure 38
Exposure signature - short-term 1

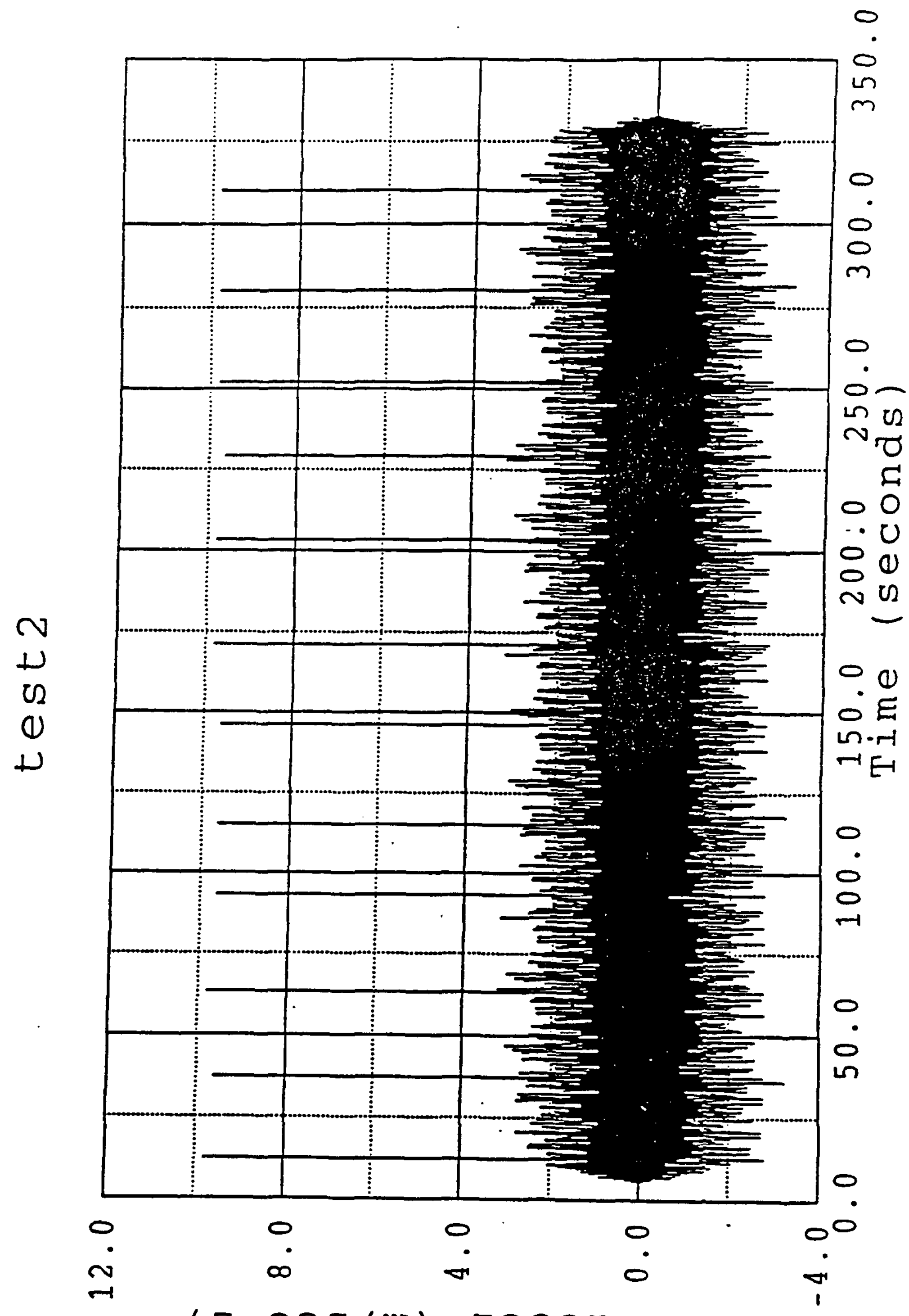


Figure 39
Exposure signature - short-term 2

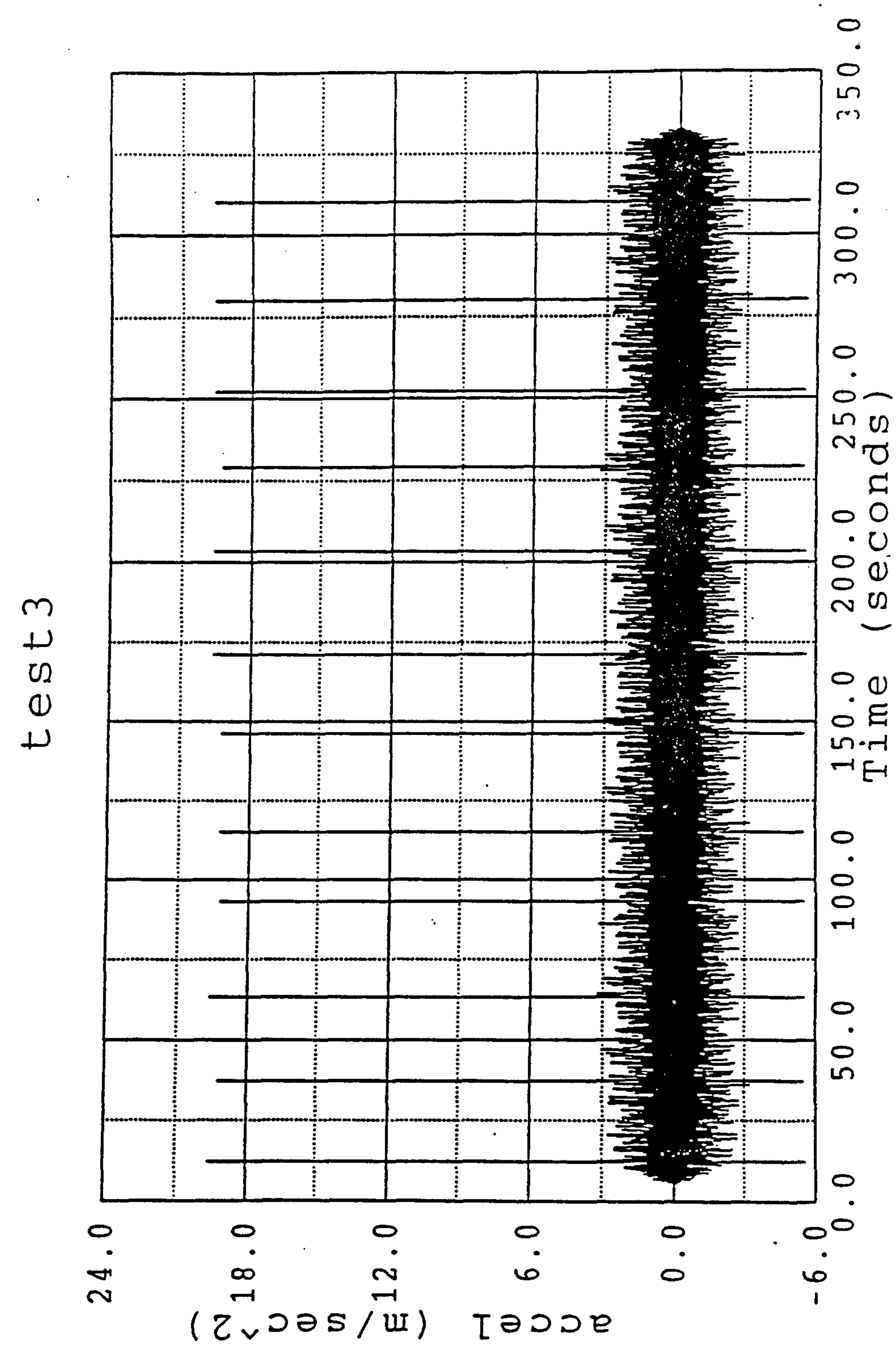


Figure 40
Exposure signature - short-term 3

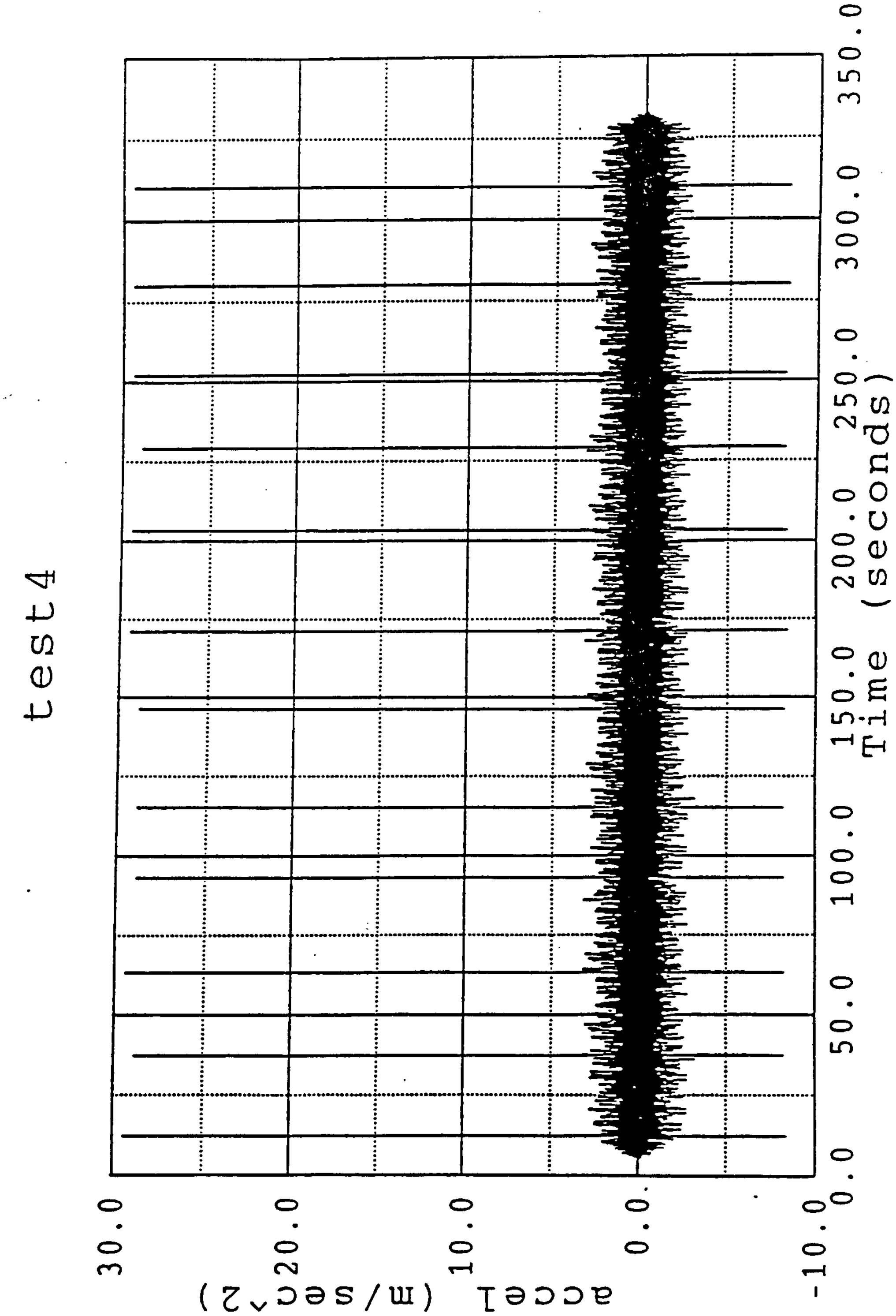


Figure 41
Exposure signature - short-term 4

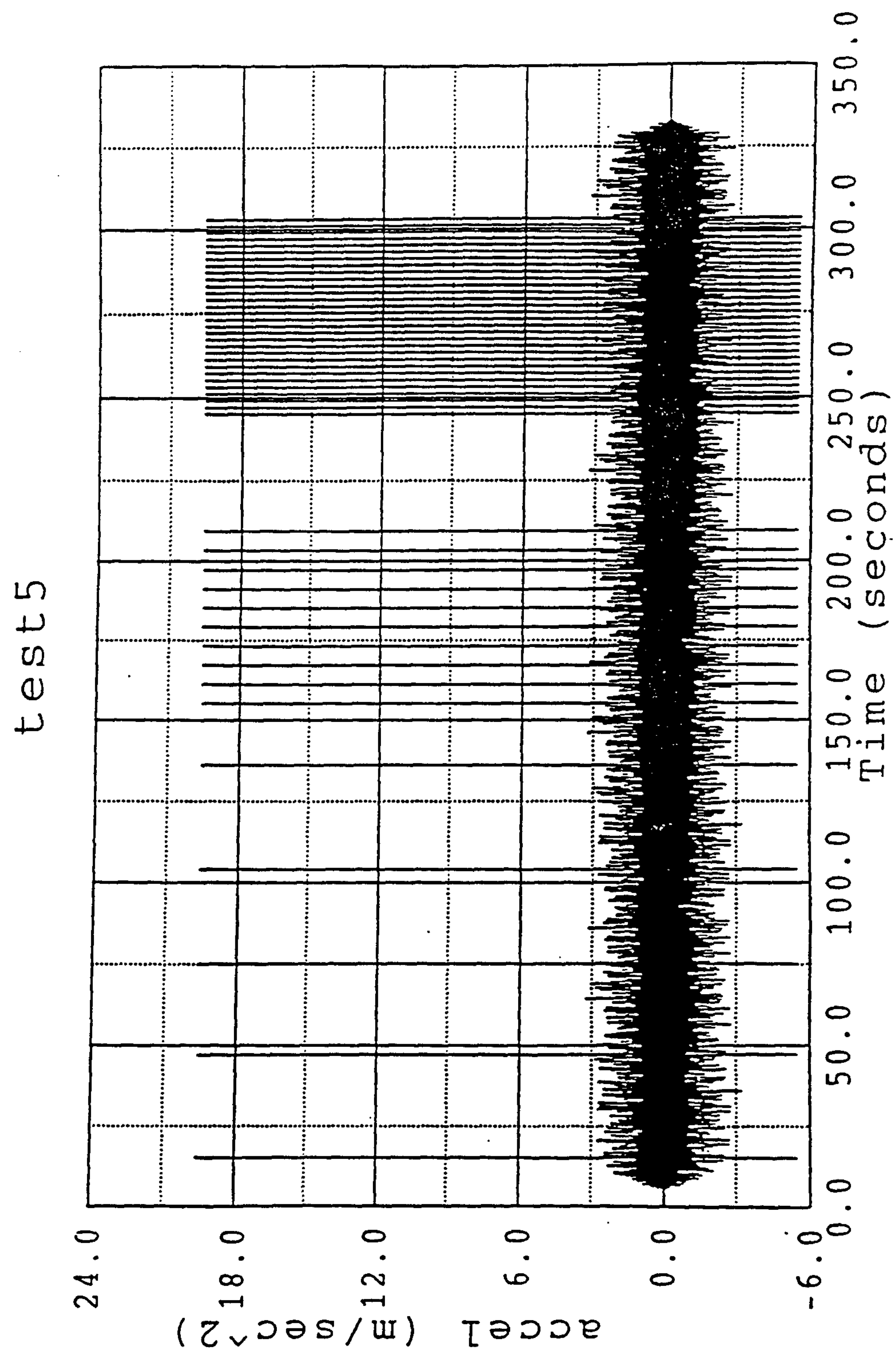


Figure 42
Exposure signature - short-term 5

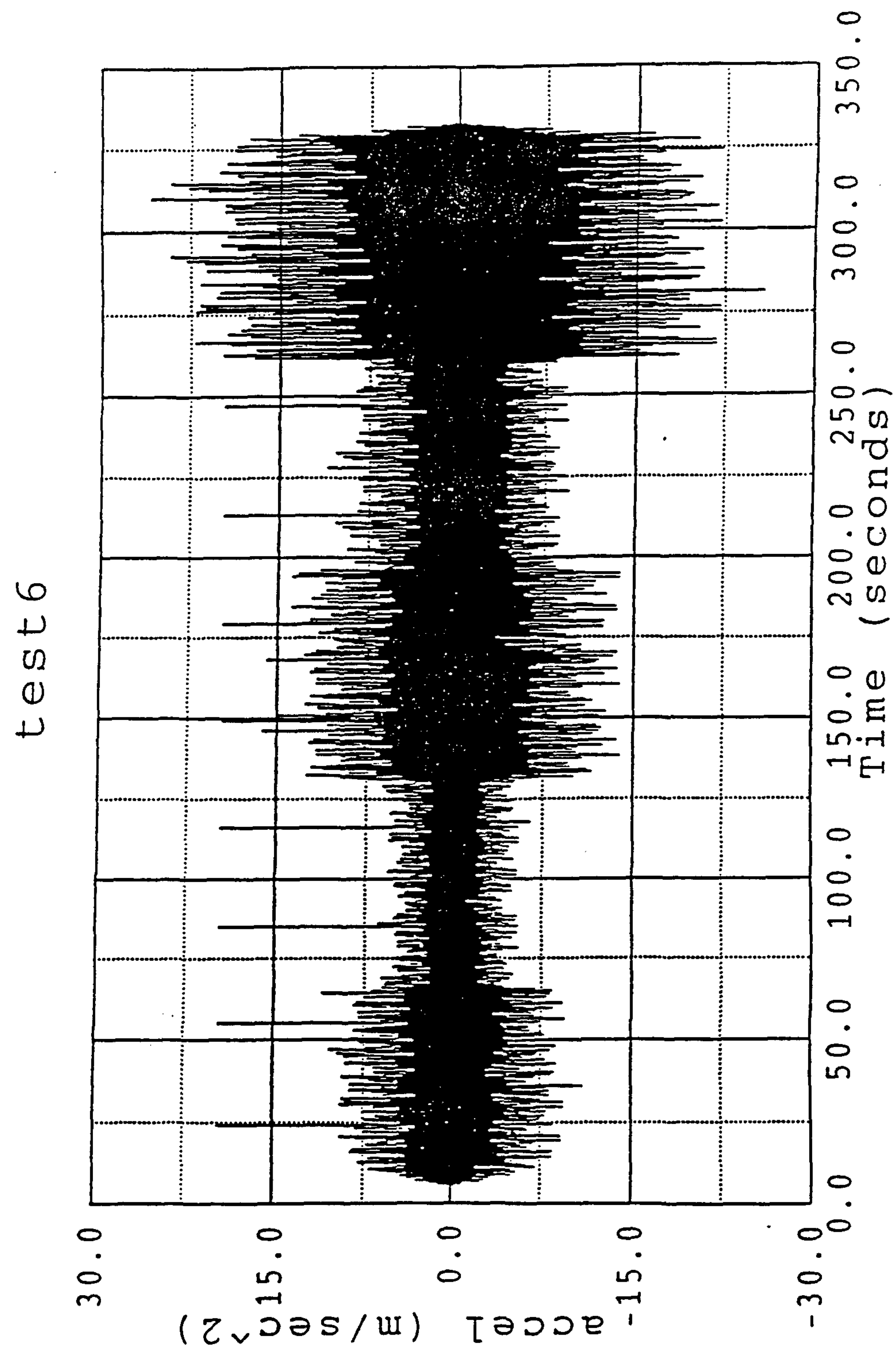


Figure 43
Exposure signature - short-term 6

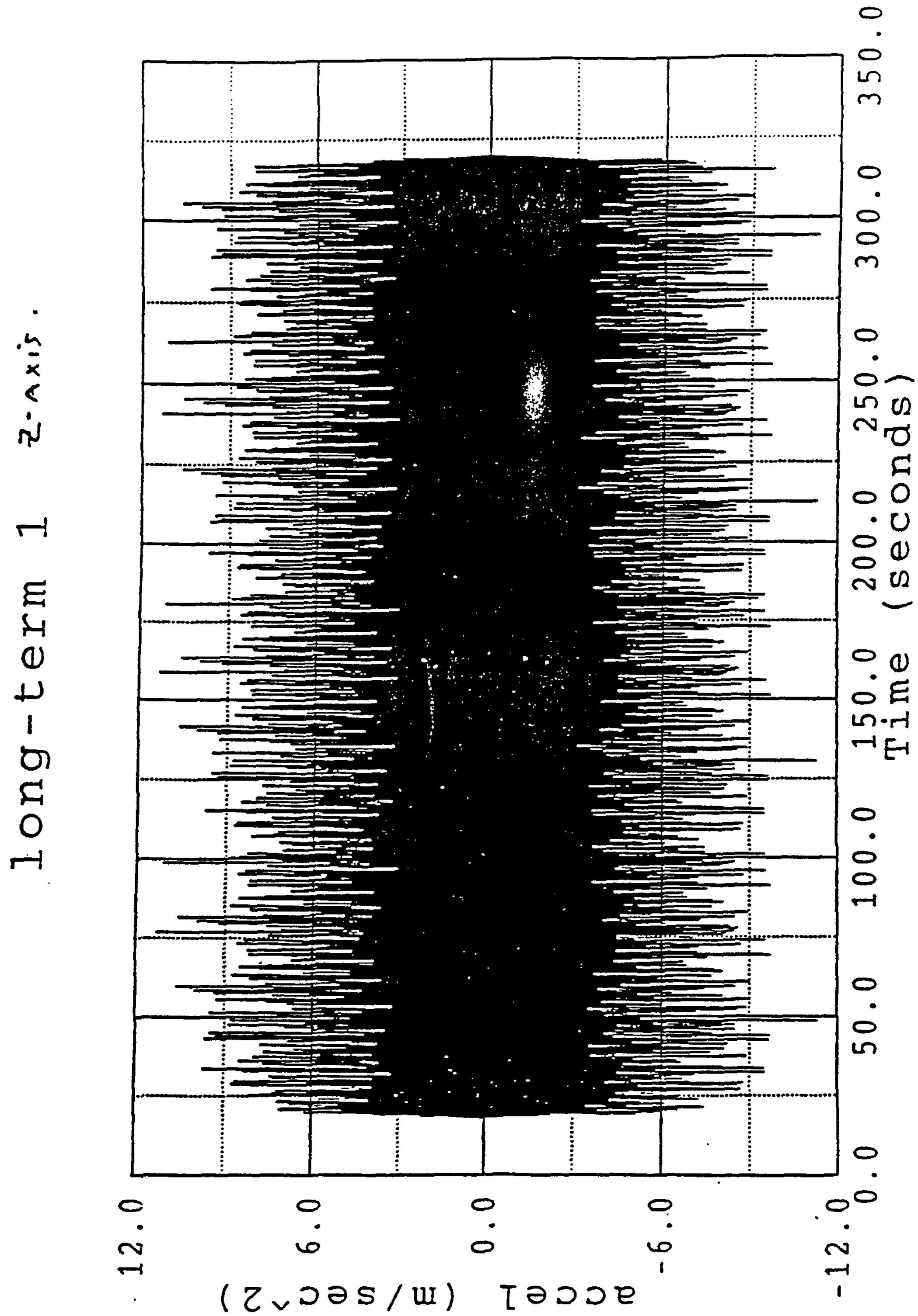


Figure 44
Exposure signature - long-term 1

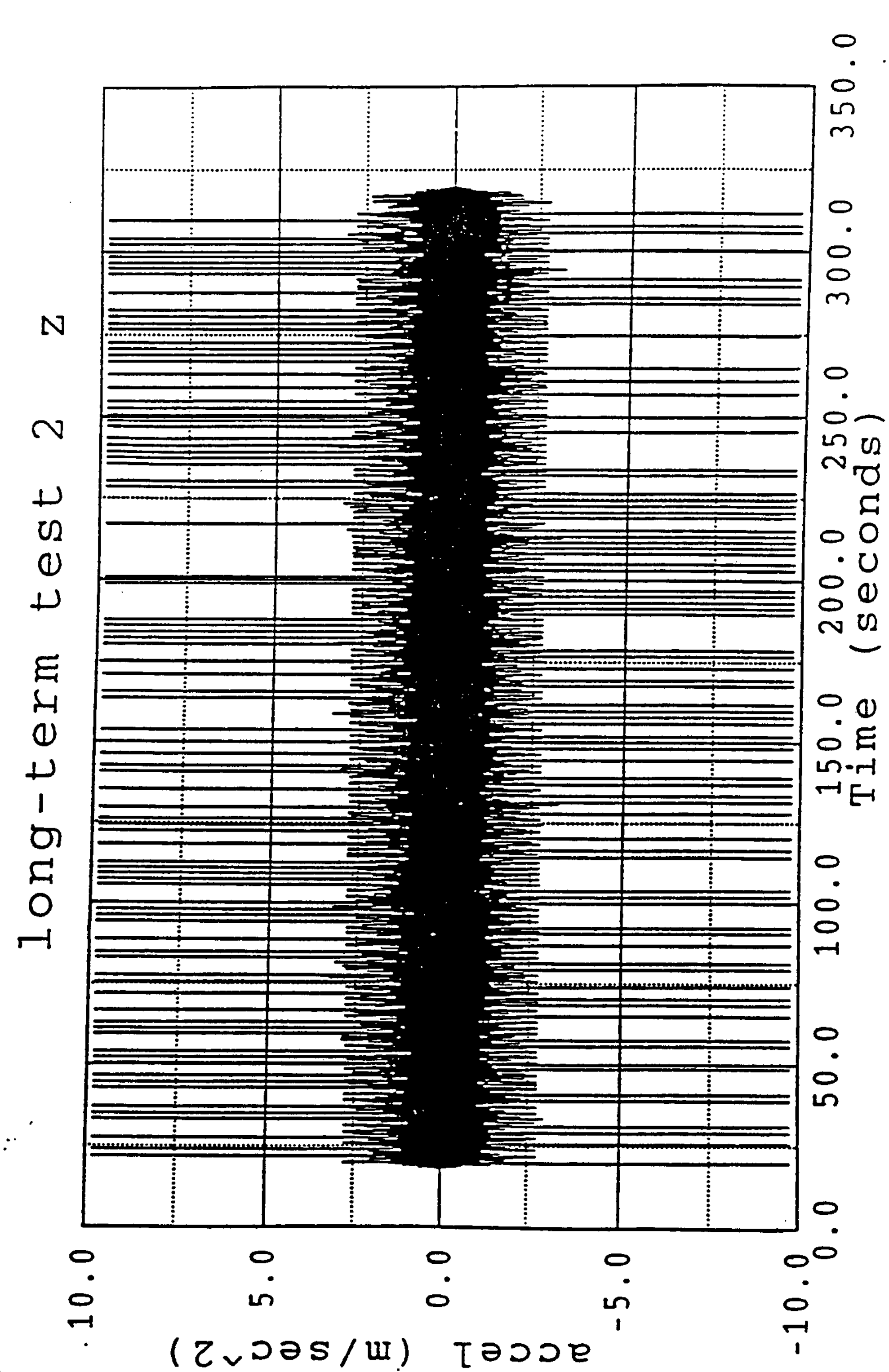


Figure 45
Exposure signature - long-term 2

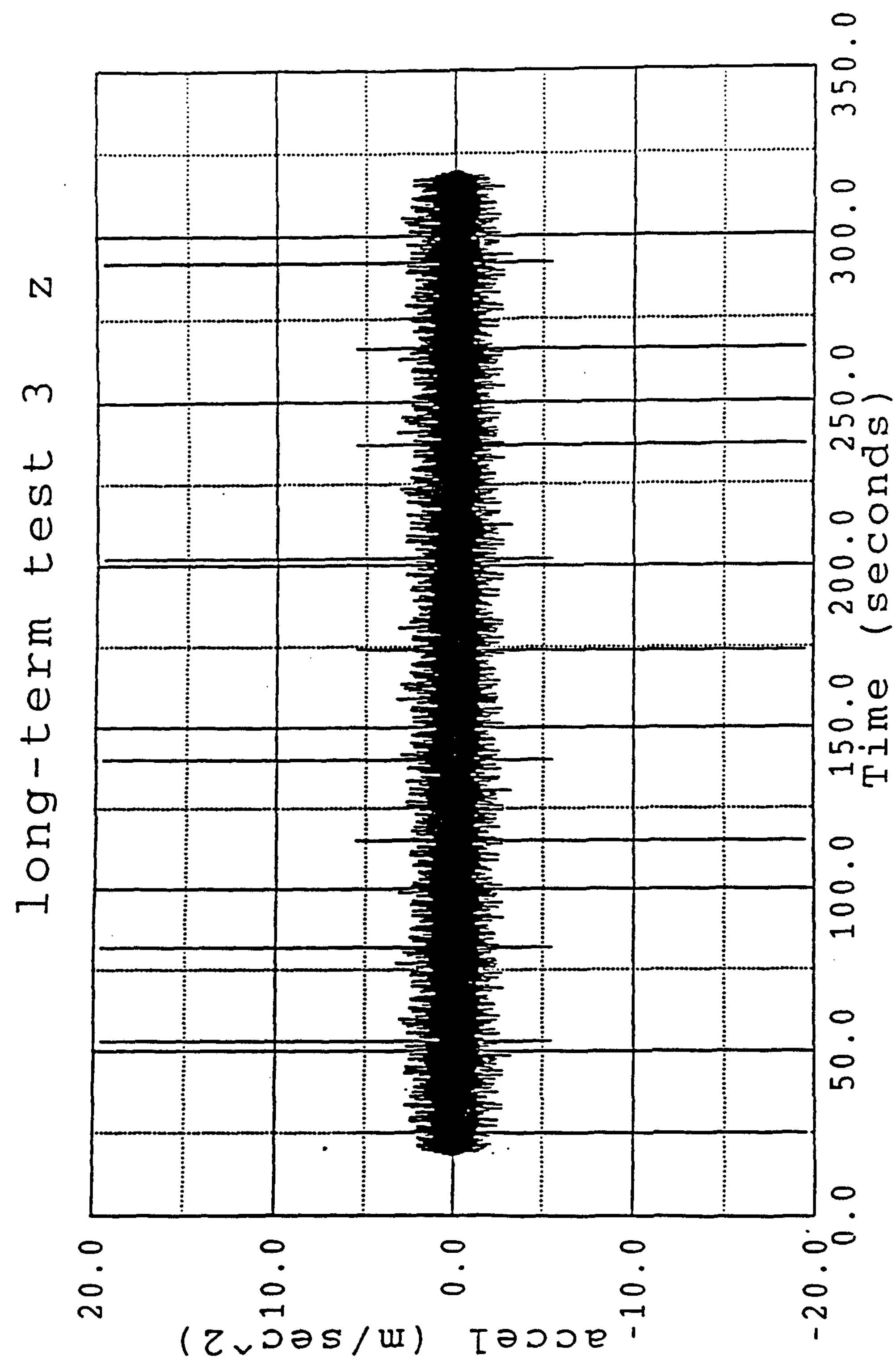


Figure 46
Exposure signature - long-term 3

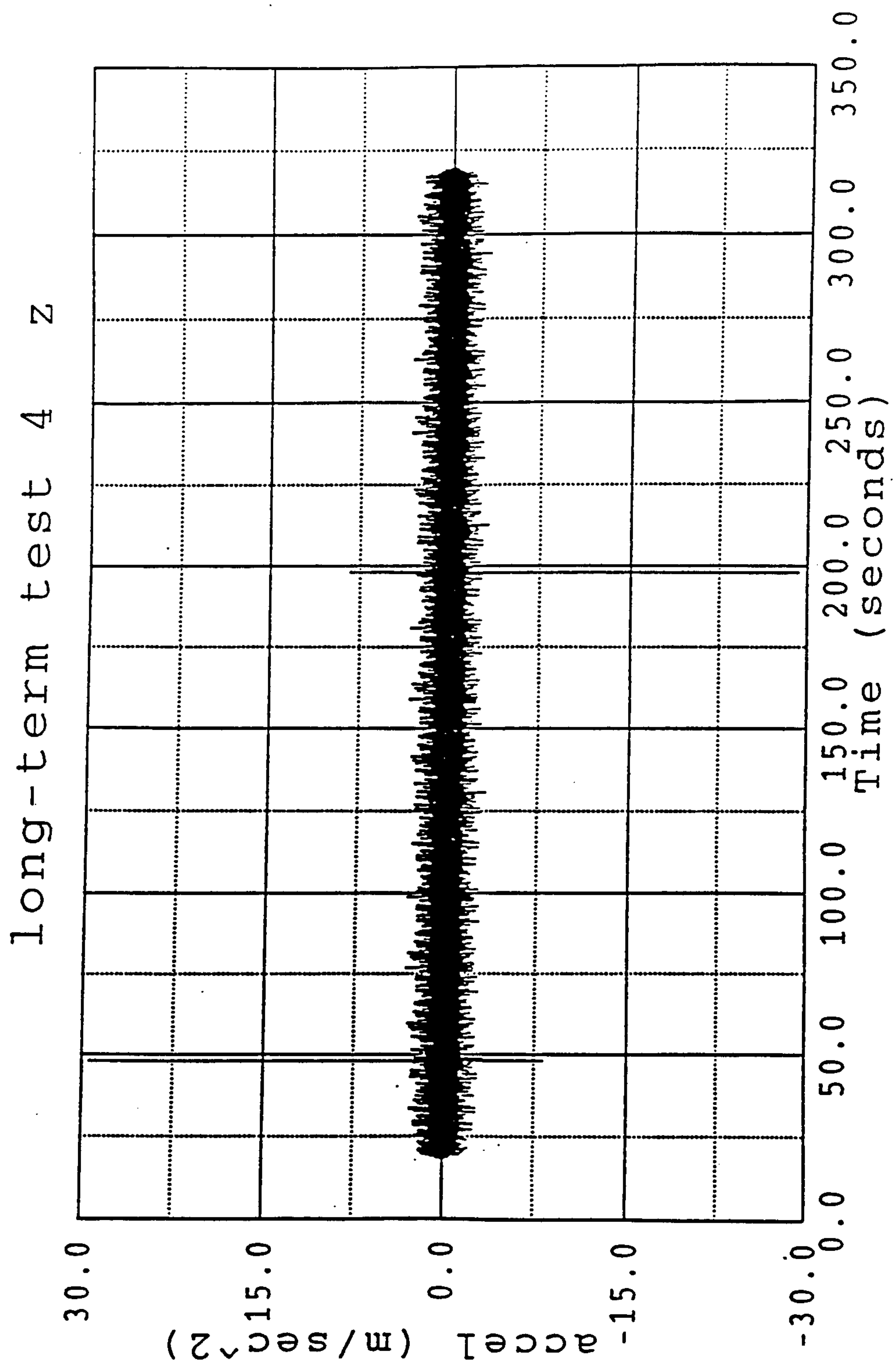


Figure 47
Exposure signature - long-term 4

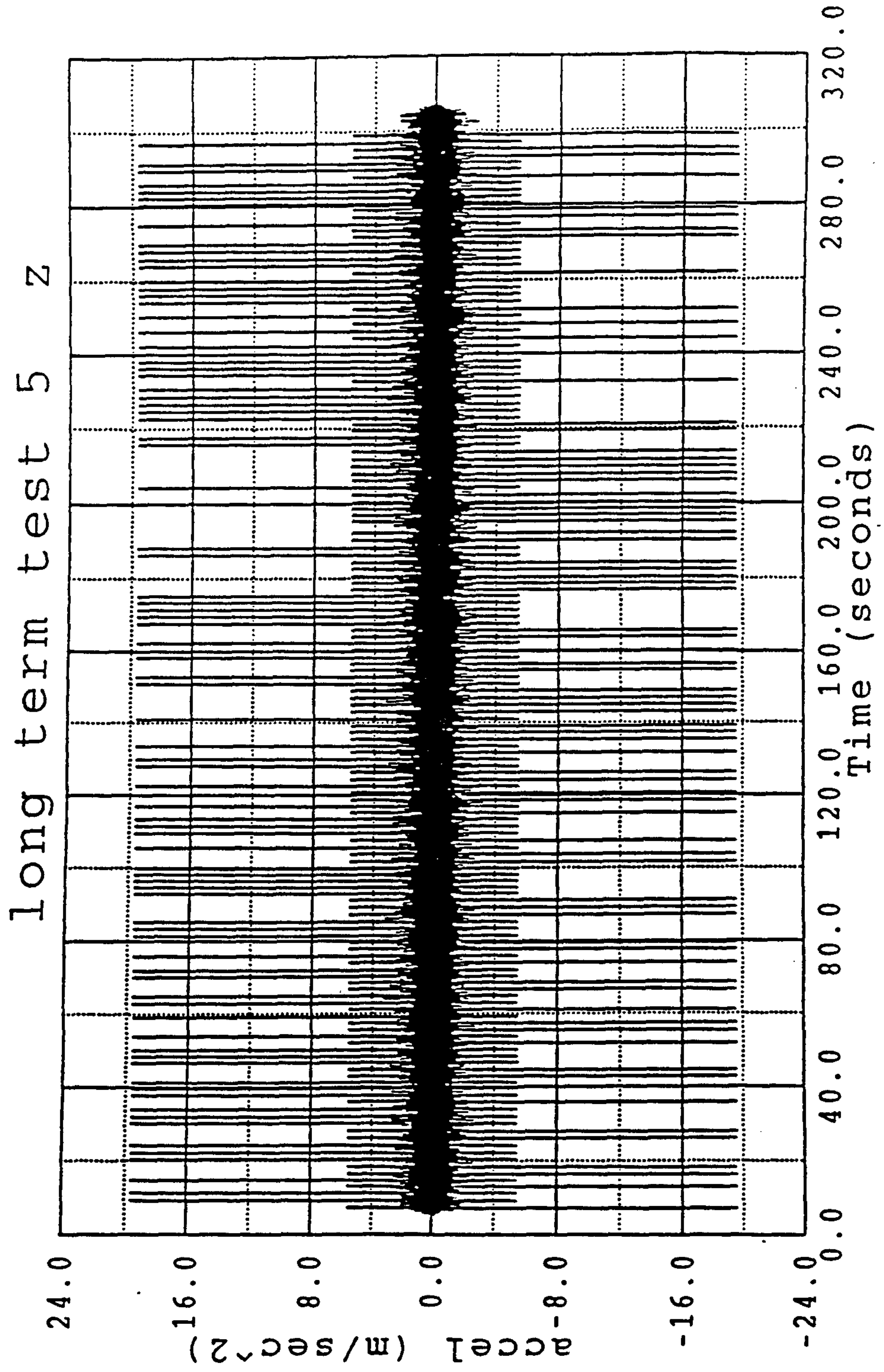


Figure 48
Exposure signature - long-term 5

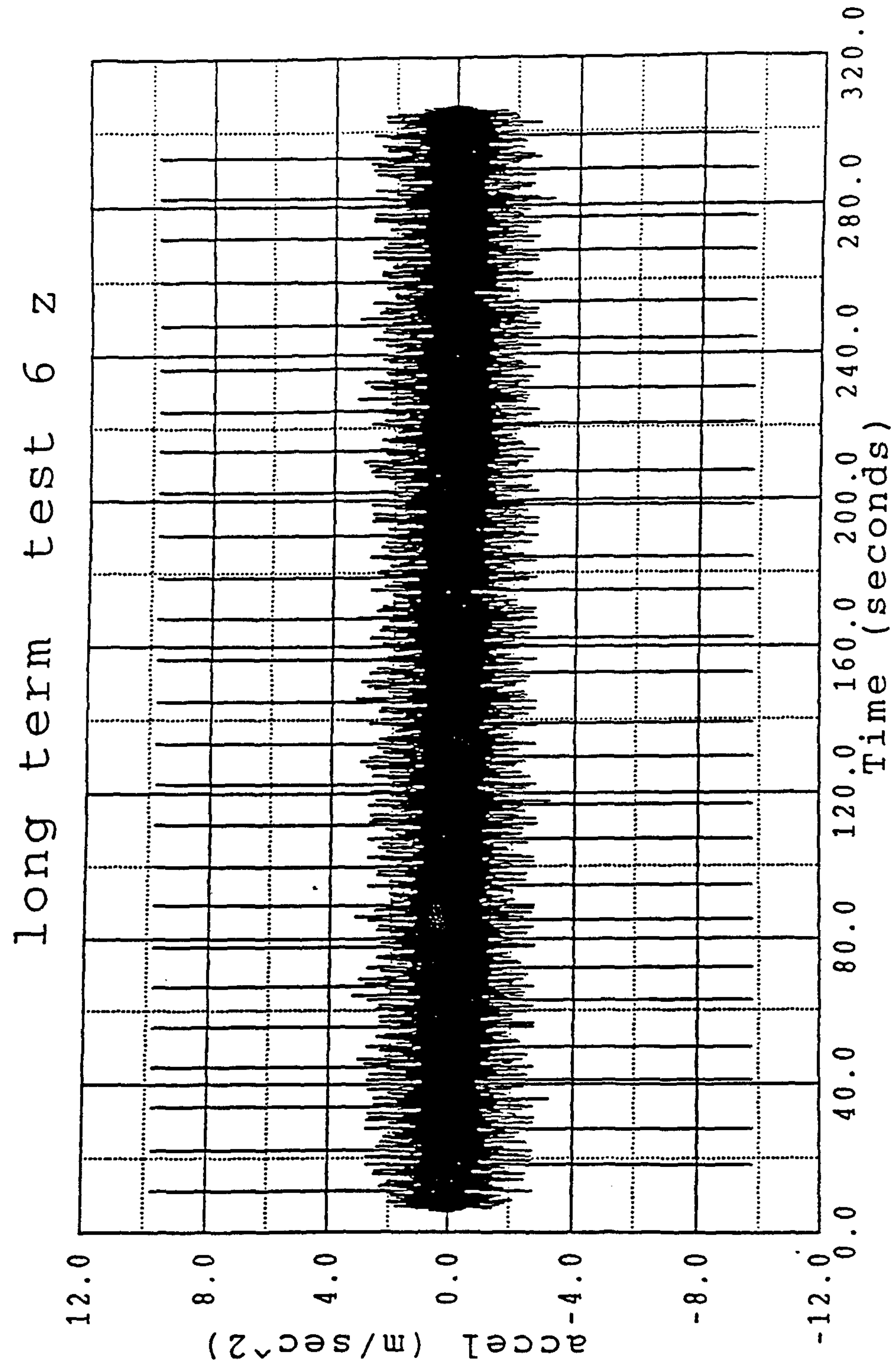
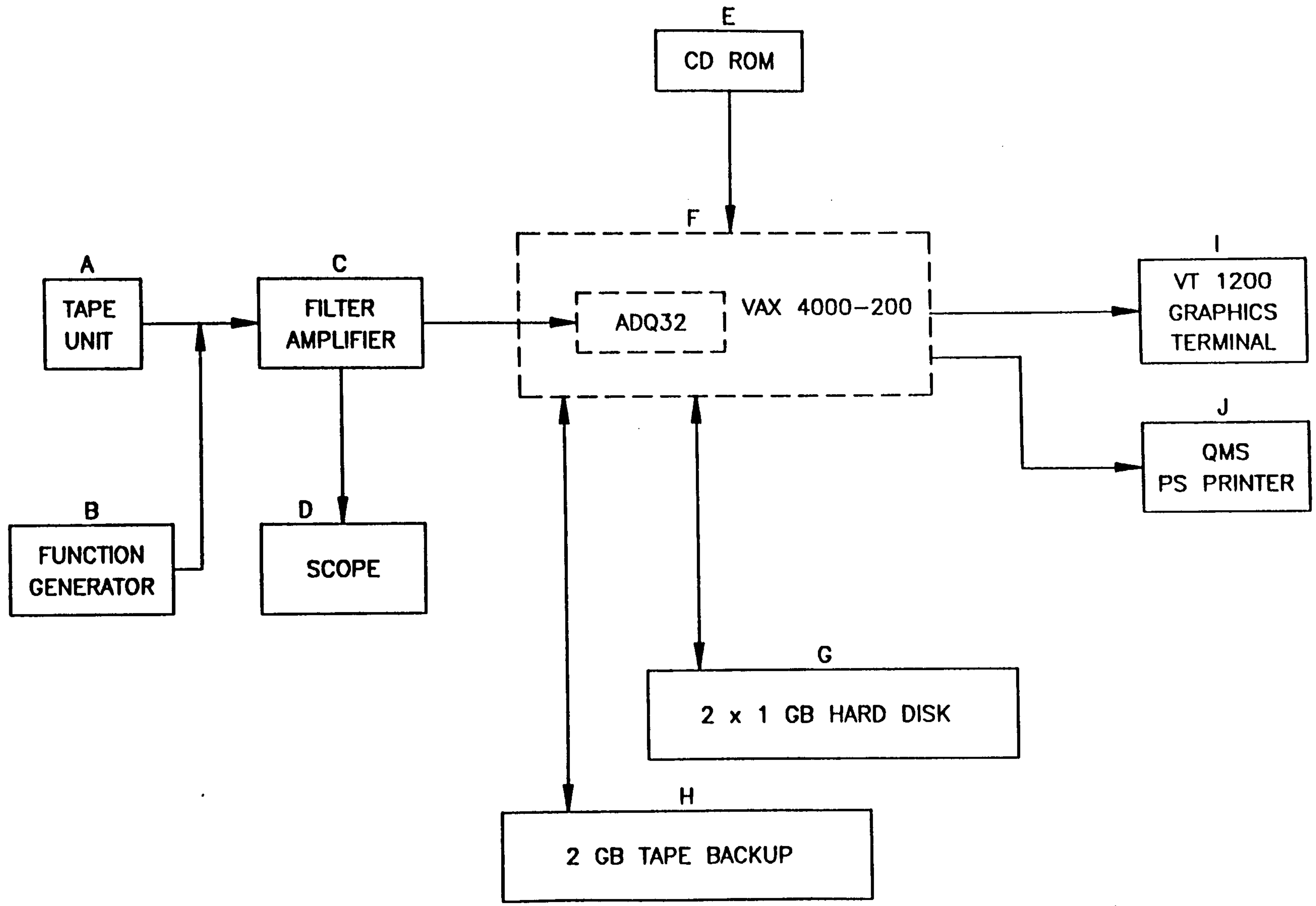


Figure 49
Exposure signature - long-term 6

Appendix A

Data Acquisition System



SYSTEM CONFIGURATION

LABORATORY CONFIGURATION

A) An XR-510 14 channel analog recorder is used to play back the data recorded during the vehicle test runs. At a tape speed of 4.8 cm/sec each data channel has a bandwidth from DC to 1.25kHz and a signal-to-noise (SN) ratio of 47dB. An audio track is usually implemented during the recording process to facilitate data queueing by providing the tank commander's comments.

B) An HP 8111A function generator is used as a system calibration reference by simulating the outputs of the accelerometers swinging through full scale.

C) An eight channel Terrascience signal filter/amplifier is used to ensure sufficient signal strength and to prevent aliasing frequencies greater than 500 Hz when the data is being sampled by the VAX.

D) A Tektronix 2213 oscilloscope is used to monitor both the raw data signals coming from the tape playback unit as well as the signal generator. It proves most useful for detecting clipped data signals.

E) A CD-ROM drive did not have any active role in the data acquisition or subsequent processing but was used to load the system software.

F) The VAX 4000-200 forms the hub of the system, controlling the data acquisition system (ADQ32) and processing the resulting data as per the defined software routines.

The ADQ32 is capable of sampling 32 single-ended channels at a maximum rate of 200,000 samples a second.

TECHNICAL SPECIFICATIONS

XR-510 Teac Data Recorder

14 channel FM recorder using VHS standard magnetic tape

* Bandwidth	DC - 1.25 kHz
* S/N ratio	47 dB
* Flutter	0.55% p-p (0.2 - 313 Hz) (meets IRIG 118-73 specs)
* Input impedance	1 Mohm unbalanced
* FM harmonic dist.	1% or less
* Crosstalk	less than noise level between channels

All measurements above taken at a tape speed of 4.76 cm/sec (1 7/8 ips)

ADQ32 Digital Equipment A/D Converter Module

* Channels	32 single-ended 16 differential
Input amplifier	
* Input impedance	10 Mohms
* Input amp accuracy	0.010% @ gain=1
* Bandwidth	950 KHz @ gain=1
* CMRR	55 dB
A/D converter	
* Conversion time	3 uSec
* Resolution	12 bits
* Diff linearity	0.2 - 2 LSB
* Integral linearity	1.5 LSB max
* Max drift over temp.	+/- 1 LSB
* Maximum throughput	200,000 samples/sec

ST41B Terrascience Analog Signal Conditioner

* Input impedance	>10 Mohms
* CMRR	90 dB (DC - 60 Hz)
* Gain accuracy	0.05%
* Filter	4-pole Butterworth low pass (fc is jumper selectable)
* Output impedance	100 ohms

Tektronix model 2213A Dual Channel Oscilloscope

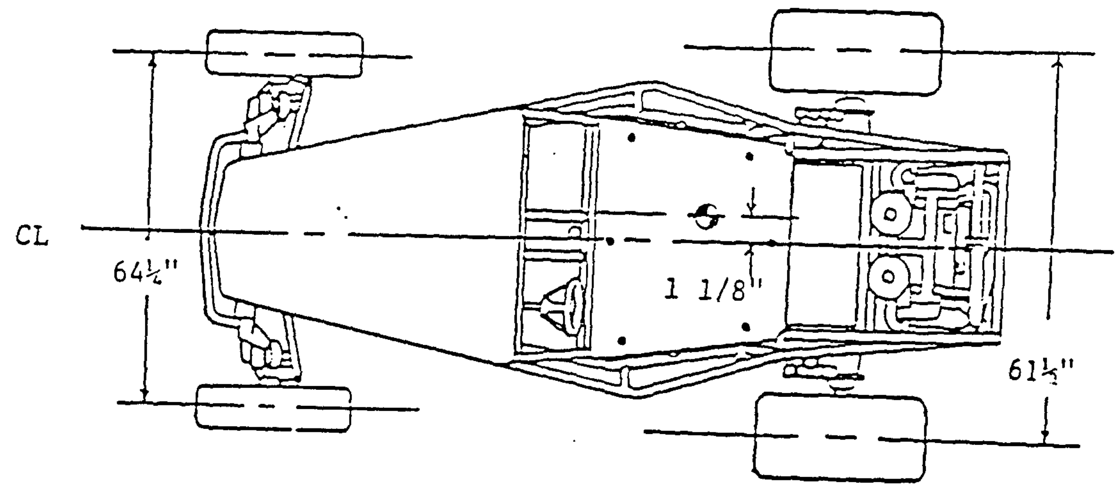
* Bandwidth	60 MHz
* Input impedance	1 Mohm

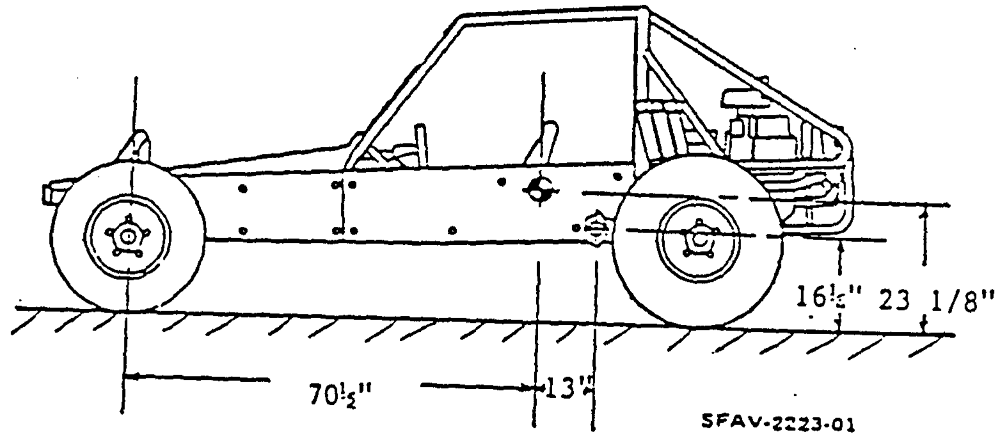
Appendix B

Description of Vehicles

CENTER OF GRAVITY

SFAV 2750 lb GVW



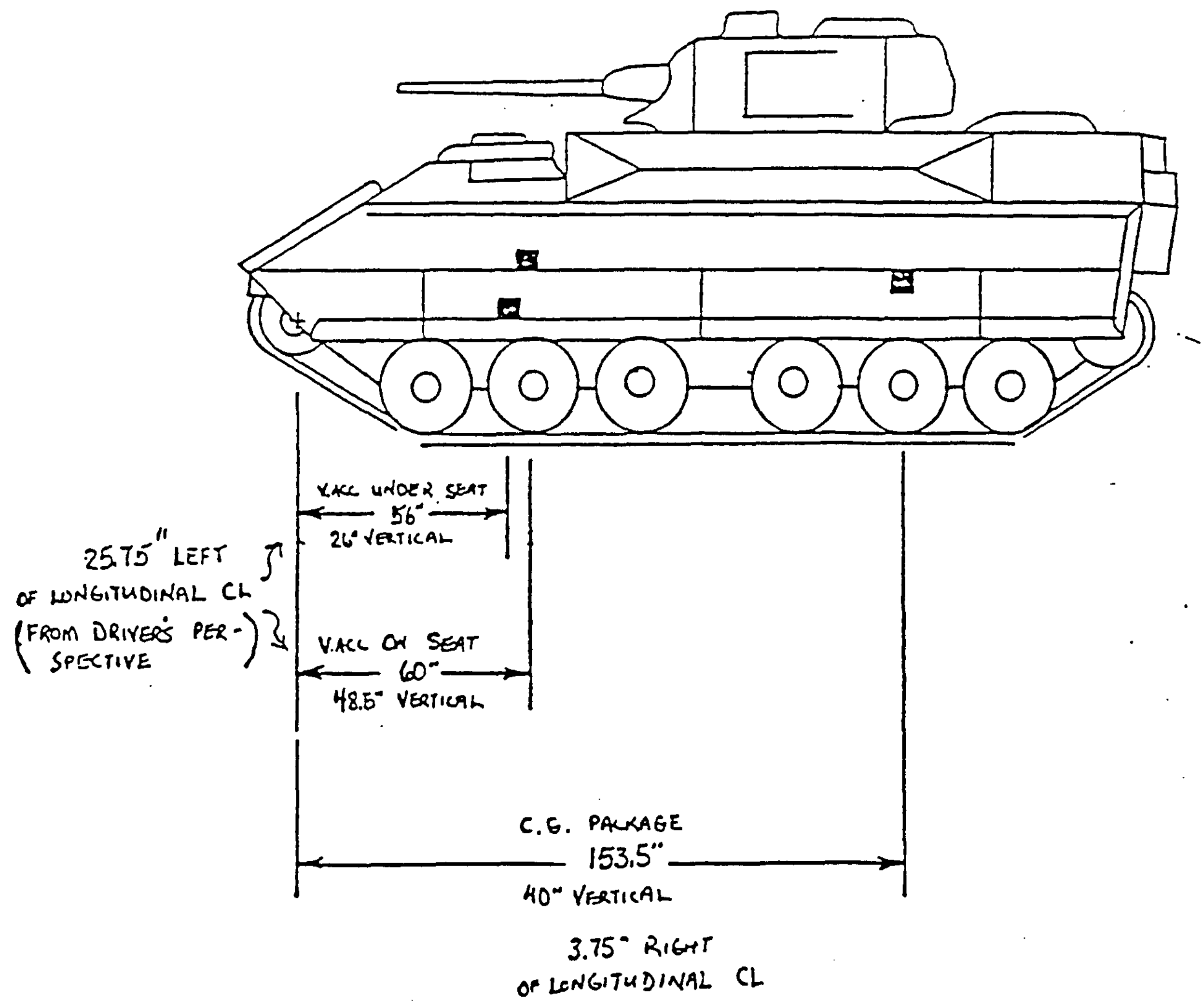


WHEEL LOADS

FRONT		REAR	
480		1000	RIGHT
	2750 TOTAL		
360		910	LEFT

Instrument Location

M-2 BRADLEY F.V.



Schematic showing locations of instrumentation on the M3

SECTION 1. INTRODUCTION

1.1 BACKGROUND

None.

1.2 DESCRIPTION OF MATERIEL

a. The M1A1 tank is a fully tracked, low profile, armored vehicle which will augment the baseline M1 as the U.S. Army's primary assault weapon. Operated by a crew of four, the 57.2-metric ton (63-ton) M1A1 is powered by a 1118-kW (1500-hp) turbine engine (AGT-1500) driving an automatic transmission (X1100-3B) which includes differential steering and braking functions. With governed maximum speed, the M1A1 can attain a top speed of 68 km/hr (42 mph) on level, hard surface roads. The torsion bar spring, rotary dampened suspension allows the M1A1 to maintain its high speed capability over cross-country terrain.

b. The M1A1's main weapon is the 120-mm M256 smoothbore cannon, which is mounted in a 360° traversable turret. The M1A1 carries 40 rounds for this weapon, 34 in the turret bustle ammunition compartment and 6 in the hull compartment. Secondary weapons include a 7.62-mm M240 machine gun coaxially mounted on the right of the main gun mount, another 7.62-mm M240 machine gun skate mounted at the loader's hatch, and a caliber .50 M2HB machine gun mounted externally at the commander's station. The M1A1 carries 1000 caliber .50 rounds and 11,400 7.62-mm rounds.

c. The M1A1 tank's fire control system features a turret, stabilized in azimuth, and a gunner's primary sight (GPS) stabilized in elevation. The GPS includes dual power day vision, a dual power thermal imaging system, a laser rangefinder, and a sight extension to the tank commander's station. Other elements of the fire control system include a digital ballistic computer, a crosswind sensor, a bustle ammunition temperature indicator, a manual muzzle reference system, a gunner's auxiliary sight, and commander's weapon sight. The M1A1 ballistic computer uses the point mass trajectory method to calculate the ballistic solution for main weapon ammunition. The gun turret drive is electronically controlled and hydraulically powered.

1.3 TEST OBJECTIVE

The objective of this test was to determine the acceleration levels at the four crew seats during operation on various test courses and to perform a ride quality analysis in terms of ISO Standard 2631-1978.

1.4 SCOPE

The Vibration Test Branch of the U.S. Army Combat Systems Test Activity (USACSTA) was responsible for instrumenting the M1A1 tank, conducting the tests, and acquiring and processing all test data. Ride quality testing was conducted on the M1A1 tank from 25 June through 30 July 1987.

M1026 HMMWV

SECTION 1. INTRODUCTION

1.1 BACKGROUND

None

1.2 DESCRIPTION OF MATERIEL

The High Mobility, Multi-Purpose, Wheeled Vehicle consists of a common chassis capable of accepting various body configurations to accommodate weapon systems, utility and ambulance roles. The vehicle used in this test is the weapons system version.

1.3 OBJECTIVES

The objectives of this test were to determine the input and response acceleration levels of various components of the TOW missile system and to measure whole-body vibration at each crew position.

1.4 SCOPE

The US Army Combat Systems Test Activity was responsible for supplying the data recording instrumentation, for conducting the test, for recording the vibration data and all data reduction. Testing was accomplished during the period of 19 and 20 September 1984. The testing covered by this report is the road shock and vibration.

M109A3E2

SECTION 1. EXECUTIVE DIGEST

1.1 SUMMARY

There was no visible damage to the M109A3E2 howitzer as a result of the road vibration and firing tests.

Ride quality data measured during the road vibration test indicated that the Six-Inch Washboard course caused the worst ride conditions. Strain levels measured during the road test were low enough to be considered insignificant. The majority of the acceleration frequency domain data indicate that the vibration energy is below 100 Hz during road operations.

As expected vibration and strain values were higher during the firing test. Shock response and shock intensity spectra were computed; the results are included in the appendices. The firing test did excite frequencies above 500 Hz at the two locations which were not low-pass filtered at 500 Hz.

No single firing condition could be considered the worst case as the highest measured levels were not consistent with the measurement location and firing configuration.

1.2 TEST OBJECTIVES

The objectives of this test were:

a. To determine whether the improved components, once integrated, function as intended.

b. To provide data which will reasonably assure that the prototype vehicle can attain the desired system hardware reliability for operations in accordance with the Howitzer Improvement Program (HIP) operational mode summary/mission profile.

c. To assess whether the selected design for each improved component is acceptable for continued test.

d. To provide data on system safety.

1.3 TESTING AUTHORITY

None.

1.4 TESTING CONCEPT

The M109A3E2 howitzer was subjected to road vibration and firing shock testing. The testing was conducted from 6 July through 19 August 1988. The Vibration Test Branch of the U.S. Army Combat Systems Test Activity was responsible for instrumenting the test item, conducting the test, and acquiring and processing all test data.

1.5 SYSTEM DESCRIPTION

The HIP is a product improvement of the M109A2/A3 (US version) and the M109A1B (Israeli version). The HIP consists of a 155-mm self-propelled howitzer (SPH), its integrated logistic support (ILS), and command, control, and communication (C^3) interfaces with the artillery fire support system.

The U.S. HIP SPH, designated the M109A3E2, is an armored, full-tracked howitzer carrying a minimum of 34 complete conventional geometry rounds and two oversized projectiles on board (Figure B-1). It is operated by a nominal crew of four, including the driver. Its main armament consists of a modified version of the M185 cannon assembly (the M284) and M178 gun mount (the XM182E1) currently employed on the M109A2/A3/A3E1. All current, as well as developmental, U.S. conventional 155-mm artillery projectiles will be system compatible. The cannon, propelling charge, and projectile mix will permit unassisted ranges of at least 22 km and a maximum assisted range of at least 30 km. A new turret structure is provided to enhance integration of the various turret improvements and vulnerability reduction measures and to improve overall crew compartment layout and space. The fire control system is fully automated, providing accurate position location and azimuth reference, onboard ballistic solutions of fire missions, and computer controlled gun drive through servos with manual backup. These improvements should permit flexibility in employment and enhance responsiveness and firing rate. The SPH is expected to fire within 30 seconds when emplaced and within 60 seconds when on the move from receipt of a fire mission. Digital and voice communications utilizing current systems, and the Signal Channel Ground/Air Radio System (SINCGARS) through an onboard communications processor, will enable dispersed operations/missions from one firing unit to multiple howitzers. Tactical and technical fire control and direction is maintained primarily through an interface with the BCS, and Advanced Field Artillery Tactical Data System (AFATDS), on both voice and digital data, through KY57 speech security devices (COMSEC).

The M109A3E2 incorporates state-of-the-art materials and technologies to achieve maximized availability and maintainability through the use of Built-in Test (BIT), Built-in Test Equipment (BITE), and Plug-in Test Equipment (PITE). This equipment provides both diagnostic and prognostic capabilities, modularity, redundancy, and reduced operating stress levels through use of a microclimatic cooling system (MCS); and application of vulnerability reduction measures for the crew and critical (i.e., mission essential) equipment. As part of preplanned product improvements, the HIP SPH design and configuration will facilitate the installation of a loader-assist mechanism and associated systems (i.e., automatic primer feed and fuze setting and electrical firing) to reduce crew labor and increase rate of fire; installation of a propellant compartmentalization design which will protect the crew and howitzer components from the effects of propellant ignition caused by hostile fire from shaped charge munitions; and provide for application of the Enhanced Position Locating and Reporting Systems User's Unit, embedded encryption, and acceptance of muzzle velocity from on-board velocimeter through the automated fire control system (AFCS). All product improved equipment will be hardened to withstand Nuclear Weapons Effects (NWE).

Tactical fire control will be maintained through the GFE Gun Control Unit COMBAT subsystem. Certain features of the AFCS for the M109A3E2 are omitted in accordance with IDF doctrine, tactics, and anticipated operational usage. These include: on-board ballistic computation, weapon drive servos, and secure digital communications. Weapon pointing is accomplished using a Gun Orientation

and Navigation System (GONS) or the Dynamic Reference Unit (DRU) of the MAPS. The fire control system will permit an emplaced howitzer, when pointed within 30 degrees of the target azimuth, to load, lay, and fire within 30 seconds of receiving a fire mission for quadrant elevations between -53 mils and 800 mils, and within 45 seconds for elevations above 800 mils. High rates of fire are provided by a loader assist mechanism with capabilities of a burst rate of fire of three rounds in 15 seconds and maximum cyclic rates of 6 rounds per minute for three minutes followed by sustained firing rates of one round per minute limited by tube thermal conditions. To monitor the tube temperature a GFE thermal sensor is installed in the US variant with displays provided for the crew on the display unit of the AFCS and by an analog display. In addition, a predictive mode, using a GFE heating/cooling software algorithm will be added to the AFCS display unit which will advise the crew and commander whether the fire mission can safely be completed without exceeding tube thermal limits.

Reliability, availability, maintainability and durability (RAM-D) improvements provided by the Howitzer Extended Life Program (HELP) kits are applied with diagnostics provided for the automotive system using STE-ICE and BIT as in the M109A3E2 for line replaceable units (LRUs). NBC protection is provided to the crew by use of a seven station GFE Ventilated Facepiece System similar to that evaluated under the HELP. Vulnerability reduction enhancements are limited to natural shielding and concentration of critical or vulnerable components and application of a GFE automatic fire extinguishing system, using Halon 1301 as the fire suppressant in the crew compartment and retaining the existing CO_2 extinguisher in the engine compartment. All product improved equipment will be hardened to withstand, as a minimum, the effects of Electromagnetic Pulse (EMP) from a nuclear event.

The vehicle tested weighs 28,000 kg (62,000 lb). The track pads were worn but were still acceptable for use.

M923A2

SECTION 1. EXECUTIVE DIGEST

1.1 SUMMARY

The ride quality of the M923A2 5-ton cargo truck, as determined by both the exposure limit and absorbed power methods, falls within acceptable limits for all test courses except Munson Belgian Block. On this course, while operating at 32.2 km/hr (20 mph), the absorbed power at the operator's seat exceeded 10 watts and the ride was therefore considered unacceptable.

1.2 TEST OBJECTIVES

The objective of this test was to determine the acceleration levels at the driver's position during mission operations and to analyze the data according to ISO Standard 2631-1978 and SAE 680091.

1.3 TESTING AUTHORITY

None.

1.4 TESTING CONCEPT

This test was conducted at Aberdeen Proving Ground, Maryland by the Vibration Test Branch of the U.S. Army Combat Systems Test Activity in accordance with SAE Recommended Practice J1013. The data were analyzed according to ISO Standard 2631-1978 and to criteria outlined in SAE report 680091. Testing was conducted during the period 15 August to 15 September 1988.

1.5 SYSTEM DESCRIPTION

The M923A2 cargo truck is a member of the M939 series of 5-ton, 6-wheel drive vehicles. These vehicles are designed for use on all types of roads, highways, and cross-country terrain. They also operate in extreme temperatures such as arctic weather conditions. The M939 series vehicles are an improved version of the M809 series. The improvements make the M939 series vehicles more reliable and easier to operate. Some of the major improvements include an automatic transmission, a three-man cab, a complete airbrake system, a tilt hood, and an hydraulically operated front winch.

All M939 and M939A1 series vehicles employ the same 250 horsepower engine. The M939A2 series vehicles use a smaller, turbocharged engine, also capable of producing 250 horsepower. Both engines utilize the same automatic transmission. Vehicle cabs have removable canvas tops. All vehicles are equipped with a spare wheel mounted at the rear of the cab and a pintle hook used for towing. The M939A2 series vehicles are equipped with a Central Tire Inflation System (CTIS) which allows for greater tactical mobility.

Machine Description of the M923A2 5-ton

Manufacturer: BMY Division of Harsco Inc., York, Pennsylvania

Serial Number: NLOQ4C

Weight

Net..9860 kg (21,740 lb)
Ballast ....4180 kg (9,220 lb)
Gross...14,040 kg (30,960 lb)
Weight Distrb (Axle 1/2/3)...................................32/33/35

Dimensions

Wheelbase..455.7 cm (179.4 in.)
Track..206.8 cm (81.4 in.)
Length...788.7 cm (310.5 in.)
Width..247.4 cm (97.4 in.)
Height...307.3 cm (121.0 in.)

Engine

Type....................................Diesel, Turbocharged, Intercooled
Cylinders...6 (In-Line)
Brake Horsepower............................250 Horsepower At 2100 RPM

Drivetrain

Transmission.......................................5-speed automatic

Suspension

Front..Leaf springs, oil shocks
Rear...Leaf springs, oil shocks

M2HS BFV

SECTION 1. INTRODUCTION

1.1 BACKGROUND

None.

1.2 DESCRIPTION OF MATERIEL

The tested vehicle is a Bradley Fighting Vehicle (BFV) with High Survivability (HS) modifications. These modifications include the addition of armor tiles and upweighting the BFV to approximately 27,220 kg (60,000 lb). The BFV is a full-tracked vehicle powered by a diesel, V-8, liquid-cooled engine.

1.3 OBJECTIVES

The objectives of these tests were:

a. To determine the shock and vibration characteristics of the BFVS-A1 HS vehicle ride (ride quality) for human factors evaluation.

b. To determine the shock and vibration environment that the explosive armor tiles will be exposed to while mounted on the BFVS-A1 HS.

c. To evaluate recently developed tie-down procedures used to secure the Bradley M2/M3 A1 HS vehicles to a wooden deck rail flatcar equipped with standard draft gears.

1.4 SCOPE

The Vibration Test Branch of the U.S. Army Combat Systems Test Activity (USACSTA) was responsible for instrumenting the Bradley, conducting the tests, and acquiring and processing all test data. Rail impact and ride quality testing was conducted on the Bradley from 20 April to 10 July 1987.

Appendix C

FORTRAN Source Code for Analysis Programs

Program	FILTV2.FOR
Program	BIODYN.FOR
Program	CREST3.FOR
Program	IMPULSE.FOR
Program	ISO.FOR
Program	SPECF.FOR
Program	APPEND.FOR
Program	MULTIXY.FOR
Program	SHOCK.FOR
Program	SNIP_GAUSSIAN.FOR
Program	ADDXY.FOR
Program	RAMP.FOR
Program	TOUSA.COM
Example	Batch File

The above programs are also supplied on IBM-PC compatible 3.5" disc which have been sent to:

U.S. Army Aeromedical Research Lab
Attn: SGRD-UAD-IV (Major Butler)
Fort Rucker, AL U.S.A.
36362-0577

Program FILTV2.FOR

PROGRAM FILTV2

```
C  begin{doc}
C*************************************************************************
 **************+++++++++++++++++++++++++++++***************************
 **************+                             +***************************
C**************+        PROGRAM FILTV2        +***************************
 **************+                             +***************************
 **************+++++++++++++++++++++++++++++***************************
C*************************************************************************
C*                                                                       *
 *--------------------------------------------------------------*
C*    Program Summary                                                    *
C*--------------------------------------------------------------*
 *                                                                       *
 *    Bandpass filtering according to British Standard 6841 by FFT       *
C*                                                  OR ISO 2631          *
 *--------------------------------------------------------------*
 *    Program Description                                                *
C*--------------------------------------------------------------*
C*                                                                       *
 *    Performs frequency weighting or filtering according to             *
 *    user specified input. The options available are British            *
C*    Standard 6841, x,y,z ISO standard 2631 x,y,z or no weighting.      *
 *    See, Handbook of Human Vibration, M. Griffin (1990).               *
 *                                                                       *
C*    The series is resampled to satisfy the 2**K requirement            *
C*    of the FFT. The FFT is performed and the spectrum is operated      *
 *    on by the appropriate transfer function or frequency weighting.    *
C*    The inverse FFT is then performed and optionally the resultant     *
C*    filtered series is resampled to its original size.                 *
 *                                                                       *
 *--------------------------------------------------------------*
C*    Definition of GEDAP Data Files                                     *
 *--------------------------------------------------------------*
 *                                                                       *
C*    INPUT_FILE_1   - Time series                                       *
C*                                                                       *
 *    OUTPUT_FILE_1  - Filtered time series                              *
C*                                                                       *
C*--------------------------------------------------------------*
 *    Definition of Conversational Input Data        ( Unit = LUCIN )    *
 *--------------------------------------------------------------*
C*                                                                       *
 *    NUMBER_OF_CYCLES  -The number of program cycles                    *
 *                       ( if negative test options are enabled)         *
C*                                                                       *
C*    IFIRH  -filter option                                              *
 *                 0 - Wb  z-axis           British Standard 6841        *
C*                 1 - Wd  x and y-axis British Standard 6841            *
C*                 2 - ISO 2631 z-axis                                   *
 *                 3 - ISO 2631 x and y-axis                             *
 *                 4 - no filtering                                      *
C*--------------------------------------------------------------*
 *    IRESAM -resampling option switch                                   *
 *                 0 - Filtered series will be resampled, i.e. output    *
C*                     series will have the same sample spacing and      *
C*                     record length as input series                     *
 *                 1 - Filtered series will not be resampled             *
 *                                                                       *
C*                                                                       *
 *    IFORR    - Output option switch ( must be enabled by setting       *
```

```
C*                                          NOCYC negative)                        *
C*                    0 - GEDAP input file                                         *
C*                    1 - filtered white noise output file, frequency domain *
C*                    2 - filtered white noise output file, time domain            *
C*                    3 - GEDAP input file, frequency domain                       *
C*                        (Note: frequency domain - amplitude spectrum)            *
C*                                                                                 *
      end{doc}                                                                     *
 *-----------------------------------------------------------*
C*     GEDAP Procedure File Example                                                *
C*-----------------------------------------------------------*
 *                                                                                 *
C*     $ ON ERROR THEN EXIT                                                        *
C*     $ RUN FILTV                                                                 *
 *     1                          ! No of cycles                                   *
C*     INPUT_FILE_1               ! time series                                    *
C*     OUTPUT_FILE_1              ! filtered time series                           *
C*     1                          ! British Standard Weighting option              *
 *     0                          ! resampling option                              *
C*     $ EXIT                                                                      *
C*                                                                                 *
 *-----------------------------------------------------------*
C*     GEDAP Header Input Parameters                                               *
C*-----------------------------------------------------------*
 *                                                                                 *
 *     N       -The number of elements in the input series                         *
C*     DEL     -The intersample spacing of the series                              *
C*     SCFI    -The common scale factor for integer data                           *
 *     FP      -Peak frequency                                                     *
C*     FPD     -Peak frequency delft                                               *
C*                                                                                 *
 *-----------------------------------------------------------*
C*     External Subroutines and Functions Called                                   *
C*-----------------------------------------------------------*
 *                                                                                 *
 *     FILTV2LIB  - British Standard 6841 filtering routine                        *
C*                - ISO weighting                                                  *
C*                                                                                 *
 *-----------------------------------------------------------*
C*     Program compiling                                                           *
C*-----------------------------------------------------------*
 *                                                                                 *
C*     @F12    -     creates object and listings - F1.lis                          *
C*                                                                                 *
 *-----------------------------------------------------------*
 *     Program Linking on VAX/VMS                                                  *
C*-----------------------------------------------------------*
C*                                                                                 *
 *     @FILTV2.LNK                                                                 *
C*                                                                                 *
C*-----------------------------------------------------------*
 *     Report any Bugs in this Space                                               *
C*-----------------------------------------------------------*
C*                                                                                 *
 *                                                                                 *
 *                                                                                 *
C*                                                                                 *
C*                                                                                 *
 *-----------------------------------------------------------*
C*     Program Development History                                                 *
C*-----------------------------------------------------------*
 *                                                                                 *
```

```
C*      Program Creation Date and Author:                              *
C*          Version 1.0 - 27 NOV 1991          - Filtv2                *
C*                        - George Roddan, BC Research                 *
C*                                                                     *
C**********************************************************************
C*                                                                     *
C*      Program Modi:  ions:                                           *
C*                                                                     *
C*      Version       Date          Author/Firm        Description     *
C*                                                                     *
C
C**********************************************************************
C***                        Module #1                                ***
C***    Parameter Statements for User Constants and Array Dimensions ***
C**********************************************************************

        IMPLICIT        NONE
C
        INTEGER*4       LIMA
        PARAMETER       ( LIMA = 262144 )
C
C**********************************************************************
C***                        Module #2                          ********
C*** Explicit Type Declarations for all Variables and Arrays   ********
C**********************************************************************
C
        INTEGER*4       LUCIN, LUCOUT, LULIST, ISTATUS
        INTEGER*4       NUMBER_OF_CYCLES, I_CYCLE, N11, N22
        REAL*4          VERSION_NUMBER
        CHARACTER*32 PROGRAM_NAME
C
        INTEGER*4       I, IER, IERR, IFIL, IFIRH, IFORR, IRESAM, ITREND, N
C
        REAL*4          A, DEL, DMEAN, FL, FP, FPD, FT1, FT2, FU, HWIN
        REAL*4          TR, TREND1, TREND2, X1, SUM, SMEAN
C
        REAL*8          A0, A1, A2
C
        COMPLEX         C, CHWIN
C
        CHARACTER*16 DATA_X, DATA_Y, UNITS_X, UNITS_Y
C
        LOGICAL         INVALID
C
        DIMENSION       A(LIMA), C(LIMA/2), CHWIN(LIMA/2), HWIN(LIMA)
C
C**********************************************************************
C***            Module #3            **********************************
C*** Initialize GEDAP System         **********************************
C**********************************************************************
C
        PROGRAM_NAME = 'FILTV2'
        VERSION_NUMBER = 1.0
        CALL OPEN_GEDAP_NOLIST ( PROGRAM_NAME, VERSION_NUMBER,
     +                             LUCIN, LUCOUT )
C
C-----------------------------------------------------------
C       Obtain the Number of Program Cycles
C-----------------------------------------------------------
C
        NUMBER_OF_CYCLES = 1
        CALL PAR_INTEGER_DEFAULT ('number of program cycles [1]',
```

```
+                                        NUMBER_OF_CYCLES )
C*********************************************************************
C***                  Module #4                  *********************
C*** Open GEDAP Input and Output File Streams    *********************
C*********************************************************************
C
      CALL PRINT_MESSAGE ( ' ' )

      CALL OPEN_INPUT_FILE_STREAM ( 1, 'input file containing'//
     +                                 ' time series',ISTATUS )
      IF (ISTATUS .NE. 0) CALL CLOSE_GEDAP ( ISTATUS )

      CALL PRINT_MESSAGE ( ' ' )

      CALL OPEN_OUTPUT_FILE_STREAM ( 1, 'output file containing'//
     +                                ' filtered time series', ISTATUS )
      IF (ISTATUS .NE. 0) CALL CLOSE_GEDAP ( ISTATUS )

      CALL PRINT_MESSAGE ( ' ' )
C
C*********************************************************************
C***                         Module #5                       ********
C*** Read Conversational Input Data using PAR_xxx Subroutines ********
C*********************************************************************
C*
C*----------------------------------------------------------*
C*    Enter Frequency Weighting as per British Standard 6841           *
C*----------------------------------------------------------*
C
      INVALID = .TRUE.
      DO WHILE ( INVALID )
         CALL PRINT_MESSAGE ('British and ISO Weighting Options: ')
         CALL PRINT_MESSAGE ('  0 - Wb  (z-axis)')
         CALL PRINT_MESSAGE ('  1 - Wd  (x and y-axis)')
         CALL PRINT_MESSAGE ('  2 - ISO (z-axis)')
         CALL PRINT_MESSAGE ('  3 - ISO (x and y-axis)')
         CALL PRINT_MESSAGE ('  4 - no filtering')
         CALL PAR_INTEGER ('Weighting Option', IFIRH )
         IF (IFIRH.LT.0 .OR. IFIRH.GT.4) THEN
            CALL PRINT_MESSAGE (' Invalid weighting option ')
         ELSE
            INVALID = .FALSE.
         ENDIF
      END DO

      CALL PRINT_MESSAGE ( ' ' )
C
C*----------------------------------------------------------*
C*    Enter output sampling option                                     *
C*----------------------------------------------------------*
C
      INVALID = .TRUE.
      DO WHILE ( INVALID )
         CALL PRINT_MESSAGE (' RESAMPLING OPTION -- ')
         CALL PRINT_MESSAGE ('  IF 0, SAMPLE SPACING OF OUTPUT ='//
     +                       ' SAMPLE SPACING OF INPUT')
         CALL PRINT_MESSAGE ('  IF 1, SAMPLE SPACING OF OUTPUT'//
     +                       ' CONTROLLED BY FFT')
         IRESAM = 0
         CALL PAR_INTEGER_DEFAULT ('resampling option [0]', IRESAM )
         IF (IRESAM.LT.0 .OR. IRESAM.GT.1) THEN
```

```
            CALL PRINT_MESSAGE ('Invalid resampling option')
         ELSE
            INVALID = .FALSE.
         ENDIF
      END DO
C
      CALL PRINT_MESSAGE ( ' ' )

 *-----------------------------------------------------------*
C
 *-----------------------------------------------------------*
 ********************************************************************
C***  S T A R T   O F   M A I N   R E C Y C L I N G   L O O P  *******
C********************************************************************
 *
      I_CYCLE = 1
      DO WHILE ( I_CYCLE .LE. NUMBER_OF_CYCLES )

 ********************************************************************
C***                 Module #6                  ******************************
C***   Read Data from GEDAP Input File          ******************************
 ********************************************************************
C
      CALL READ_GEDAP_1 ( 1, LIMA, DEL, X1, N, A, DATA_X, UNITS_X,
     +                    DATA_Y, UNITS_Y, ISTATUS )
      IF (ISTATUS .NE. 0) CALL CLOSE_GEDAP ( ISTATUS )
C
 *-----------------------------------------------------------*
 ***         U S E R   C O D E   S T A R T S   H E R E              ***
C*-----------------------------------------------------------*
C
 *-----------------------------------------------------------*
C*    Remove mean (always done)                                        *
C*                                                                     *
 *-----------------------------------------------------------*

 2222 CONTINUE

         SUM=0.
         DO I=1,N
            SUM=A(I)+SUM
         END DO
         SMEAN=SUM/N
C*-----------------------------------------------------------*
         DO I=1,N
             A(I) = A(I) - SMEAN
         END DO

 *-----------------------------------------------------------*
C*                                                                     *
C*       APPLY FREQUENCY WEIGHTING AS PER BRITISH STANDARD 6841
 *                                                                     *
C*-----------------------------------------------------------*
C
     CALL FLTV(LUCOUT,A,C,N,LIMA,FL,FU,DEL,FT1,FT2,IRESAM,IFIRH,
    +         HWIN,CHWIN,IFORR,IER)
C
C********************************************************************
C Throw away first and last 2% of record to avoid filter end effects  *
C********************************************************************
     N11= .02*N
     N22= .98*N
```

```
      N=N22-N11+1
     DO I=1,N
        A(I)=A(I+N11)
     END DO
C
C*********************************************************************
C***            Module #7                ******************************
C***   Write Data to GEDAP Output File   ******************************
C*********************************************************************
C
C
C------------------------------------------------------------
C      Store Parameters in GEDAP Output File Header
C------------------------------------------------------------
C
C
C------------------------------------------------------------
C      Write GEDAP Output File
C------------------------------------------------------------
C
     CALL WRITE_GEDAP_1 ( 1, DEL, X1, N, A, DATA_X, UNITS_X, DATA_Y,
    +                UNITS_Y, PROGRAM_NAME, VERSION_NUMBER, ISTATUS )
     IF (ISTATUS .NE. 0) CALL CLOSE_GEDAP ( ISTATUS )
C
C*********************************************************************
C***  E N D   O F   M A I N   R E C Y C L I N G   L O O P  ***********
C*********************************************************************
C*
     I_CYCLE = I_CYCLE + 1
     END DO
C
C*********************************************************************
C***            Module #8                ******************************
C*** Close GEDAP and Terminate Program ******************************
C*********************************************************************
C
     CALL CLOSE_GEDAP ( 0 )
     CALL EXIT
     END
C
C
C
C
C
     SUBROUTINE FLTV ( LUE,A,C,N,LIMA,F1,F2,DT,FT1,FT2,IRESAM,
    .IFIRH,HWIN,CHWIN,IFORR,IER)
C*
C*********************************************************************
C***************++++++++++++++++++++++++++*****************************
C***************+                        +*****************************
C***************+    SUBROUTINE FLTV     +*****************************
C***************+                        +*****************************
C***************++++++++++++++++++++++++++*****************************
C*********************************************************************
C*                                                                   *
C*------------------------------------------------------*
C*    SUBROUTINE SUMMARY                                             *
C*------------------------------------------------------*
C*                                                                   *
C*    This routine performs filtering or weighting                   *
C*    of an input time series using a frequency window technique.    *
C*                                                                   *
C*------------------------------------------------------*
```

```
 *    SUBROUTINE DESCRIPTION                                         *
 *---------------------------------------------------------------*
C*                                                                   *
C*    1. Find TN, the length of the wave train, and DF, the frequency *
 *         step size.                                                *
C*                                                                   *
C*    2. Find K such that N < 2**K < 2**N, where N is the number of  *
 *         sample points in the time series.                         *
 *                                                                   *
C*    3. Resample the input array from size N to size NK             *
 *         where NK = 2**K.                                          *
 *                                                                   *
C*    4. Determine the appropriate weighting function.               *
C*         ie., according to British Standard 6841                   *
 *                                                                   *
C*    5. Perform a real to complex FFT on A, with the result         *
C*         being in C.                                               *
 *                                                                   *
 *    6. Calls the specified weighting subroutine to filter the     *
C*         complex frequency series C.                               *
C*                                                                   *
 *    7. Perform a complex to real FFT on C, with the result         *
C*         being in A.                                               *
C*                                                                   *
 *    8. Optionally perform resampling on the filtered wave train.   *
 *         If resampling is not performed, then reset DT and N.      *
C*                                                                   *
 *    9. Return to main program.                                     *
 *                                                                   *
C*---------------------------------------------------------------*
 *    INPUT PARAMETERS                                               *
 *---------------------------------------------------------------*
C*                                                                   *
C*    LUE    - logical unit number for output                        *
 *    A      - input time series to filtered                         *
 *    C      - dummy complex array used for working storage. It should *
C*              be equivalenced in the main program to the array A.  *
 *    N      - number of elements of input time series A             *
 *    LIMA   - dimensioned size of the array                         *
 *    F1     - lower cutoff frequency in Hz                          *
 *    F2     - upper cutoff frequency in Hz                          *
 *    FT1    - lower transition frequency band                       *
 *    FT2    - upper transition frequency band                       *
 *    DT     - intersample spacing of input time series A, in seconds *
 *    IRESAM - switch which controls resampling option               *
 *    IFIRH  - filter option switch                                  *
 *    HWIN   - ema array where the hamming window coefficients  are  *
 *              stored for the hamming filter routine                *
 *    CHWIN  - complex working array of hamming window coefficients  *
 *    IFORR  - output debug option                                   *
 *                                                                   *
 *---------------------------------------------------------------*
 *    OUTPUT PARAMETERS                                              *
 *---------------------------------------------------------------*
 *                                                                   *
 *    A      - filtered time series                                  *
 *    N      - number of elements of input time series A             *
 *    DT     - intersample spacing of filtered time series           *
 *    LUE    - retained to maintain calling sequence                 *
 *                                                                   *
 *---------------------------------------------------------------*
 *    LOCAL VARIABLES                                                *A
```

```
C*---------------------------------------------------------*
C*                                                                        *
C*    TN      - length of wave train (N*DT)                               *
C*    DF      - frequency step size (1/TN)                                *
C*    NK      - the size of the resampled time series. NK must be a       *
C*                power of two and satisfy the conditions                 *
C*                        NK <= LIMA                                      *
C*                        NK >= N                                         *
C*                                                                        *
C*---------------------------------------------------------*
C*    SUBROUTINES CALLED:                                                 *
C*---------------------------------------------------------*
C*                                                                        *
C*    EQUIV_CMPLX_TO_REAL - converts COMPLEX to REAL*4, REAL*4            *
C*                                                                        *
C*    EQUIV_REAL_TO_CMPLX - converts ( REAL*4, REAL*4 ) to COMPLEX        *
C*                                                                        *
C*    FBRIT - filters a complex frequency array using one                 *
C*                of the seven frequency weights specified in             *
C*                British Standard 6841                                   *
C*    FCOEF - converts a complex frequency array into a real              *
C*              frequency array                                           *
C*                                                                        *
C*    FFTCM - complex to real scale and reorder                           *
C*                                                                        *
C*    FFTEM - complex to complex FFT                                      *
C*                                                                        *
C*    FFTRM - real to complex scale and reorder                           *
C*                                                                        *
C*    ESIZN - resamples an array to a desired larger size                 *
C*                                                                        *
C*    TWLOG - finds NK such that the conditions are satisfied             *
C*                                                                        *
C*===========================================================================*
C*                                                                        *
C*    Programmed by: D. Loewen and E. Funke                               *
C*    For Hydraulics Laboratory                                           *
C*          National Research Council                                     *
C*          Ottawa                                                        *
C*    April 1983                                                          *
C*    Version 1.0                                                         *
C*                                                                        *
C**************************************************************************
C*                                                                        *
C*    Subroutine Modifications:                                           *
C*                                                                        *
C*    Version      Date         Author/Firm        Description            *
C*      1.0     27 NOV 1991     George Roddan      Frequency Weighting    *
C*                              BCR                Brit. Stan. 6841       *
C*---------------------------------------------------------*
C* Converted to VAX/VMS Version 2  8 Dec 1987         Tyson Haedrich/NRC  *
C*---------------------------------------------------------*
C*                                                                        *
C**************************************************************************
C
      IMPLICIT     NONE
C
      INTEGER*4    IER, IFIRH, IFORR, IRESAM, K, LIMA, LUE, MK, N, NK
C
      REAL*4       A, DF, DT, F1, F2, FT1, FT2, HWIN, TN
C
      COMPLEX      C, CHWIN
```

```
C
      DIMENSION  A(LIMA), C(LIMA/2), CHWIN(LIMA/2), HWIN(LIMA)
C
C*    Find the length of the wave train and the frequency step size          *
C
      TN = N*DT
      DF = 1/TN
C
C*    Find K such that N < 2**K < 2*N                                        *
C
      CALL TWLOG(N,262144,K,NK)
      IF (2*N .EQ. NK) THEN
         NK = N
         K  = K - 1
      ENDIF
      IF (NK .GT. LIMA) THEN
         CALL ERROR_MESSAGE (1,2,'FLTA','Resampled time series'//
     +                        ' larger than array A',' ',' ')
         CALL CLOSE_GEDAP ( -1 )
      ENDIF
C
C*    Resample the input array                                               *
C
      CALL ESIZN(A,N,NK)
C
C*    Perform real to complex FFT on A                                       *
C
      MK = K - 1
C
      CALL EQUIV_REAL_TO_CMPLX ( A, C, LIMA )
C
      CALL FFTEM(C,MK,-1)
      CALL FFTRM(C,NK)
C
      CALL EQUIV_CMPLX_TO_REAL ( A, C, LIMA )
C
C*-------------------------------------------------------------*
C*    Weight the complex frequency array using the user specified          *
C*    filter weighting.                                                      *
C*-------------------------------------------------------------*
C
                  CALL EQUIV_REAL_TO_CMPLX ( A, C, LIMA )
                  CALL FBRIT(LUE,C,DF,NK,IFIRH,IER)
                  CALL EQUIV_CMPLX_TO_REAL ( A, C, LIMA )
C
C*-------------------------------------------------------------*
C*    Perform a complex to real FFT on C                                     *
C*-------------------------------------------------------------*
C
      CALL EQUIV_REAL_TO_CMPLX ( A, C, LIMA )
C
      CALL FFTCM(C,NK)
      CALL FFTEM(C,MK,1)
C
      CALL EQUIV_CMPLX_TO_REAL ( A, C, LIMA )
C
C*-------------------------------------------------------------*
C*    Optionally perform resampling on resultant wave train. If             *
C*    resampling not performed then reset DT and N                           *
C*-------------------------------------------------------------*
C
      IF (IRESAM .EQ. 0)  THEN
```

```
          CALL ESIZN(A,NK,N)
      ELSE
          DT = TN/NK
          N  = NK
      ENDIF
C
      RETURN
C
C************************************************************************
                          END
C************************************************************************
C
! DEC/CMS REPLACEMENT HISTORY, Element FILTA.FOR
! *2      24-MAR-1989 13:52:45 SYSTEM ""
! *1      26-JAN-1988 08:20:53 SYSTEM "Low,high or bandpass filter by FFT"
! DEC/CMS REPLACEMENT HISTORY, Element FILTA.FOR
```

```
C*************************************************************
C ****    Program  FILTV2LIB.for                           ****
C ****                                                     ****
C*************************************************************
C*************************************************************
C
C     Subroutine library for the program FILTV2
C
C*************************************************************
C*************************************************************
C
C -------------------------------------------------------------
C     Converted to GEDAP Version II
C -------------------------------------------------------------
C
C*------------------------------------------------------------*
C
C
      SUBROUTINE FBRIT (LUE,C,DELF,NK,IFIRH,IER)

C**************************************************************
C**************+++++++++++++++++++++++++++++*******************
C**************+                           +*******************
C**************+   SUBROUTINE FBRIT        +*******************
C**************+                           +*******************
C**************+++++++++++++++++++++++++++++*******************
C**************************************************************
C*                                                            *
C*------------------------------------------------------------*
C*    SUBROUTINE SUMMARY                                      *
C*------------------------------------------------------------*
C*                                                            *
C*    SELECT FREQUENCY WEIGHTING AND FILTER IN THE FREQUENCY DOMAIN *
C*    ACCORDING TO BRITISH STANDARD 6841, or ISO.             *
C*                                                            *
C*------------------------------------------------------------*
C*    SUBROUTINE DESCRIPTION:                                 *
C*------------------------------------------------------------*
C*                                                            *
C*    BASICALLY PERFORMS BAND-PASS FILTERING IN THE FREQUENCY DOMAIN *
C*                                                            *
C*    Compile instructions - @F22 - then this is linked to FILTV2 *
C*                                 using @filtv2.lnk          *
C*------------------------------------------------------------*
C*    INPUT PARAMETERS                                        *
C*------------------------------------------------------------*
C*                                                            *
C*    LUE    - logical unit number for error messages         *
C*    C      - complex frequency array (of A), to be filtered *
C*    DELF   - intersample spacing of the freqency array      *
C*    NK     - number of elements in the resamples array A    *
C*    IFIRH  - integer code which determines which weighting function *
C*                                                            *
C*------------------------------------------------------------*
C*    OUTPUT PARAMETERS                                       *
C*------------------------------------------------------------*
C*                                                            *
C*    IER    - an error indicator                             *
C*    C      - filtered frequency array                       *
C*                                                            *
C*------------------------------------------------------------*
C*    LOCAL VARIABLES                                         *
C*------------------------------------------------------------*
```

```
C*                                                                      *
 *    NK          - number of elements in the complex freq. array C    *
 *                                                                      *
C*----------------------------------------------------------------------*
C*    SUBROUTINES AND FUNCTIONS CALLED:                                 *
 *----------------------------------------------------------------------*
C*                                                                      *
C*----------------------------------------------------------------------*
 *                                                                      *
C*    Subroutine Creation Date and Author:                              *
C*        Version 1.0 - 28 Nov. 1991                                    *
C*                     - George Roddan, BC                              *
C*                                                                      *
C*----------------------------------------------------------------------*
C*                                                                      *
C*    Subroutine Modifications:                                         *
C*                                                                      *
C*    Version          Date              Author/Firm                    *
C*      1.0          9 Dec 1991        George Roddan/bcr                *
C*      2.0          3 Feb 1992        George Roddan/bcr                *
C*      2.5         23 Jul 1992        George Roddan/bcr                *
C*                                                                      *
 *    Description:  This module has been updated to reflect the         *
C*                  current GEDAP program standards.                    *
C*                                                                      *
C***********************************************************************

      IMPLICIT     NONE
C
      INCLUDE  'G2$:GGP.FOR'
C
      CHARACTER*32 FILTER_TYPE
      INTEGER*4    I, IFIRH, IER, LUE, N1, N2, N3, N4, NK, NKH,N1MAX
C     INTEGER*4    N5
C
      REAL*4       DELF, A1, B1, C1, D1, E1, G1, FT1, FT2, PI
      REAL*4       F1, F2, F3, F4, F5, F6, Q1, Q2, Q3, Q4, K, W
      REAL*4       TPI, FPI, H
C
      COMPLEX      C, Hb, H1, S, Z1, Z2, Z3, Z4
C
C     N5=GGP$NFFT_MAX/2
C
      DIMENSION    C(131072), Hb(131072), H1(131072)
      DIMENSION    H(131072)
C
      PARAMETER    ( PI = 3.141592654 )
C
      NKH = NK/2 + 1
      TPI = 2.*PI
      FPI = 4.*PI**2.
C
C*--------------------------------------------------------------------*
C*    First define the frequency weighting array
C*******************************************************************
C****************** British Standard z-axis ************************
C*******************************************************************
C
      IF (IFIRH .EQ. 0) THEN
         F1 = 0.4
         F2 = 100.
         Q1 = 0.71
         F3 = 16.0
```

```
         F4 = 16.0
         F5 = 2.50
         F6 = 4.00
         Q2 = .550
         Q3 = 0.90
         Q4 = 0.95
          K = 0.40
         FILTER_TYPE = ' British 6841 - z'
         CALL PUT_CHARACTER_PARAMETER ('FILTER_TYPE',FILTER_TYPE)
      GO TO 50
      ENDIF

C*****************************************************************
C****************** British Standard x and y axis *****************
C*****************************************************************
C
      IF (IFIRH .EQ. 1) THEN
         F1 = 0.4
         F2 = 100.
         Q1 = 0.71
         F3 = 2.0
         F4 = 2.0
         Q2 = .630
          K = 1.0
         FILTER_TYPE = ' British 6841 - x,y'
         CALL PUT_CHARACTER_PARAMETER ('FILTER_TYPE',FILTER_TYPE)
      GO TO 60
      ENDIF

C*****************************************************************
C*********************** ISO Z-axis ******************************
C*****************************************************************
C
      IF (IFIRH .EQ. 2) THEN
         FILTER_TYPE = ' ISO 2631 - z'
         CALL PUT_CHARACTER_PARAMETER ('FILTER_TYPE',FILTER_TYPE)
         GO TO 80
      ENDIF

C
C*****************************************************************
C*********************** ISO xand y-axis *************************
C*****************************************************************
C
      IF (IFIRH .EQ. 3) THEN
         FILTER_TYPE = ' ISO 2631 - x,y'
         CALL PUT_CHARACTER_PARAMETER ('FILTER_TYPE',FILTER_TYPE)
         GO TO 90
      ENDIF
C
C
C*****************************************************************
C*********************** No Filtering ****************************
C*****************************************************************
      IF (IFIRH .EQ. 4) THEN
         FILTER_TYPE = ' no weighting'
         CALL PUT_CHARACTER_PARAMETER ('FILTER_TYPE',FILTER_TYPE)
         GO TO 200
      ENDIF

C*****************************************************************
C************** Wb - Z-axis British Standard Weighting **************
```

```
C*********************************************************************
50      DO I = 1,NKH
              W=TPI*FLOAT(I)*DELF
              S=cmplx(0.0,W)
              Z1 = (S + TPI*F3)*(S**2 + (TPI*F5*S/Q3) + FPI*F5**2)
              Z2 = (S**2 + (TPI*F4*S/Q2) + FPI*F4**2)
              Z3 = (S**2 + (TPI*F6*S/Q4) + FPI*F6**2)
              Z4 = (TPI*K*(F4**2)*(F6**2))/(F3*(F5**2))
C
              H1(I)= (Z1*Z4)/(Z2*Z3)

        END DO
        GO TO 70
*********************************************************************
************** Wb - x and y-axis British Standard Weighting ********
C********************************************************************
C
 0      DO I = 1,NKH
              W=2*PI*FLOAT(I)*DELF
              S=cmplx(0.0,W)
              Z1 = S + (TPI*F3)
              Z2 = (S**2) + (TPI*F4*S/Q2) + (FPI*(F4**2))
              Z3 = TPI * K * (F4**2) / F3
              H1(I) = (Z1/Z2)* Z3
        END DO
C
C********************************************************************
************** BAND LIMIT FILTER ***********************************
********************************************************************
C
 0      DO I = 1,NKH
              W=2*PI*FLOAT(I)*DELF
              S=cmplx(0.0 , W)
              Z1 = (S**2) * FPI * (F2**2)
              Z2 = (S**2) + (TPI*F1*S/Q1) + (FPI*(F1**2))
              Z3 = (S**2) + (TPI*F2*S/Q1) + (FPI*(F2**2))
              Hb(I) = Z1 / (Z2*Z3)
        END DO
        GO TO 100

********************************************************************
****************** ISO z-Axis **************************************
********************************************************************

0       DO I = 1,NKH
              W=FLOAT(I-1)*DELF
              IF ((W .GT. 1.0) .AND. (W .LT. 4.0)) THEN
                  H(I)= .5*(w)**.5
              ENDIF
              IF ((W .GT. 4.0) .AND. (W .LT. 8.0)) THEN
                  H(I)= 1.0
              ENDIF
              IF ((W .GT. 8.0) .AND. (W .LT. 100.0)) THEN
                  H(I)= 8/W
              ENDIF
              IF ((W .LT. 1.0) .OR. (W .GT. 100)) THEN
                  H(I)= 0.0
              ENDIF
        END DO
        GO TO 150

********************************************************************
```

```
C****************** ISO x and y-Axis *******************************
 ****************************************************************
C
90      DO I = 1,NKH
              W=FLOAT(I-1)*DELF
              IF ((W .GT. 1.0) .AND. (W .LT. 2.0)) THEN
                  H(I)= 1.0
              ENDIF
              IF ((W .GT. 2.0) .AND. (W .LT. 100.0)) THEN
                  H(I)= 2./W
              ENDIF
              IF ((W .LT. 1.0) .OR. (W .GT. 100)) THEN
                  H(I)= 0.0
              ENDIF
        END DO
        GO TO 150
C
C*---------------------------------------------------------------------*
 *   Filter the signal in the frequency domain for British Standard   *
 *---------------------------------------------------------------------*
C
 00   DO I= 1, NKH
         C(I) = C(I)*H1(I)*Hb(I)
      END DO
      GO TO 200

C*---------------------------------------------------------------------*
C*   Filter the signal in the frequency domain for ISO Standard        *
 *---------------------------------------------------------------------*

150   DO I= 1, NKH
         C(I) = C(I) * H(I)
      END DO
C
C*---------------------------------------------------------------------*
 00   RETURN
C
C*---------------------------------------------------------------------*
      END
 *---------------------------------------------------------------------*
C
C
C
C
      SUBROUTINE FCOEF (A,C,N,NK,DELF,DEL)
C
 **********************************************************************
C**************+++++++++++++++++++++++++++******************************
C***************+                           +***************************
C***************+     SUBROUTINE FCOEF      +***************************
C***************+                           +***************************
C**************+++++++++++++++++++++++++++******************************
 **********************************************************************
C*                                                                    *
C*--------------------------------------------------------------------*
C*   SUBROUTINE SUMMARY                                               *
C*--------------------------------------------------------------------*
C*                                                                    *
C*   Subroutine used to convert a complex frequency array into        *
C*   'real' frequency array.                                          *
C*                                                                    *
C*--------------------------------------------------------------------*
C*   SUBROUTINE DESCRIPTION                                           *
```

```
C*----------------------------------------------------------------------*
 *                                                                      *
C*    Subroutine used to convert a complex frequency array into         *
C*    a 'real' frequency array.                                         *
 *                                                                      *
 *----------------------------------------------------------------------*
C*    INPUT PARAMETERS                                                  *
C*----------------------------------------------------------------------*
 *                                                                      *
C*    C      - complex frequency array                                  *
C*    DELF   - intersample spacing of frequency array                   *
 *    NK     - number of elements in array C                            *
 *                                                                      *
C*----------------------------------------------------------------------*
C*    OUTPUT PARAMETERS                                                 *
 *----------------------------------------------------------------------*
C*                                                                      *
C*    A      - absolute value frequency array                           *
 *    N      - number of elements in array A                            *
C*                                                                      *
C*----------------------------------------------------------------------*
 *    SUBROUTINES AND FUNCTIONS CALLED:                                 *
 *----------------------------------------------------------------------*
C*                                                                      *
C*    none                                                              *
 *                                                                      *
C*----------------------------------------------------------------------*
C*                                                                      *
 *    Subroutine Creation Date and Author:                              *
 *        Version 1.0 - 23 Dec. 1983                                    *
C*                    - Don G. Smith, DMR                               *
C*                                                                      *
 *----------------------------------------------------------------------*
C*                                                                      *
C*    Subroutine Modifications:                                         *
 *                                                                      *
C*    Version           Date               Author/Firm                  *
C*      1.0             23 Dec. 1983       Don G. Smith/DMR             *
 *                                                                      *
 *    Description:  Original                                            *
C*                                                                      *
C*      1.1             22 Jan. 1985       Harold Chard/DMR             *
 *                                                                      *
C*    Description:  This module has been updated to reflect the         *
C*                  current GEDAP program standards.                    *
 *                                                                      *
 ***********************************************************************
C
      IMPLICIT      NONE
      INTEGER*4     I, N, NK
      REAL*4        A, DEL, DELF
      COMPLEX       C
      DIMENSION     A(*), C(*)
      N =NK
      DEL = DELF

      DO I = 1,NK
         A(I) = CABS(C(I))
      END DO

      RETURN
C
 *----------------------------------------------------------------------*
```

Program BIODYN.FOR

```
      PROGRAM BIODYN
C
C  begin{doc}
C*************************************************************************
C***************+++++++++++++++++++++++++++++***************************
C***************+                           +***************************
C***************+      PROGRAM BIODYN       +***************************
C***************+                           +***************************
C***************+++++++++++++++++++++++++++++***************************
C*************************************************************************
C*                                                                      *
C*----------------------------------------------------------------------*
C*    Program Summary                                                   *
C*----------------------------------------------------------------------*
C*                                                                      *
C*   This program is used to estimate whole-body vibrations using an   *
C*   an idealized single degree of freedom mass spring damper system.  *
C*                                                                      *
C*----------------------------------------------------------------------*
C*    Program Description                                               *
C*----------------------------------------------------------------------*
C*                                                                      *
C*    Performs frequency weighting or filtering utilizing a single     *
C*    degree of freedom model. The user is queried for                  *
C*    which model to use. The series is resampled to satisfy the 2**K  *
C*    requirement of the FFT. A forward FFT is performed on the        *
C*    the time series. The resulting spectrum is multiplied by the     *
C*    appropriate transfer function and an inverse FFT is performed    *
C*    back to the time domain.                                          *
C*                                                                      *
C*----------------------------------------------------------------------*
C*    Definition of GEDAP Data Files                                    *
C*----------------------------------------------------------------------*
C*                                                                      *
C*    INPUT_FILE_1   -  Time series                                     *
C*                                                                      *
C*    OUTPUT_FILE_1  -  Filtered time series                            *
C*                                                                      *
C*----------------------------------------------------------------------*
C*    Definition of Conversational Input Data     ( Unit = LUCIN )     *
C*----------------------------------------------------------------------*
C*                                                                      *
C*    NUMBER_OF_CYCLES  -The number of program cycles                   *
C*                ( if negitive test options are enabled)               *
C*                                                                      *
C*    IFIRH  -filter option                                             *
C*                0 - Payne Spinal (DRI)                                *
C*                1 - Payne Visceral                                    *
C*                2 - Body Vibration Model                              *
C*                3 - Griffin & Fairlea                                 *
C*----------------------------------------------------------------------*
C*    IRESAM -resampling option switch                                  *
C*                0 - Filtered series will be resampled, i.e. output    *
C*                    series will have the same sample spacing and      *
C*                    record length as input series                     *
C*                1 - Filtered series will not be resampled             *
C*                                                                      *
C*                                                                      *
C*    IFORR    - Output option switch ( must be enabled by setting      *
C*                                      NOCYC negitive)                 *
C*                0 - GEDAP input file                                  *
C*                1 - filtered white noise output file, frequency domain *
C*                2 - filtered white noise output file, time domain     *
```

```
C*              3 - GEDAP input file, frequency domain                  *
 *                  (Note: frequency domain - amplitude spectrum)       *
 *                                                                      *
C    end{doc}                                                           *
 *----------------------------------------------------------------------*
 *    GEDAP Procedure File Example                                      *
C*----------------------------------------------------------------------*
C*                                                                      *
 *    $ ON ERROR THEN EXIT                                              *
 *    $ RUN FILTV                                                       *
C*    1                         ! No of cycles                          *
 *    INPUT_FILE_1              ! time series                           *
 *    OUTPUT_FILE_1             ! filtered time series                  *
C*    1                         ! transfer function option              *
 *    0                         ! resampling option                     *
 *    $ EXIT                                                            *
 *                                                                      *
C*----------------------------------------------------------------------*
 *    GEDAP Header Input Parameters                                     *
 *----------------------------------------------------------------------*
C*                                                                      *
 *    N      -The number of elements in the input series                *
 *    DEL    -The intersample spacing of the series                     *
C*    SCFI   -The common scale factor for integer data                  *
 *    FP     -Peak frequency                                            *
 *    FPD    -Peak frequency delft                                      *
 *                                                                      *
C*----------------------------------------------------------------------*
 *    External Subroutines and Functions Called                         *
 *----------------------------------------------------------------------*
C*                                                                      *
 *    BIO    - Transfer Function filtering routine                      *
 *                                                                      *
 *                                                                      *
C*----------------------------------------------------------------------*
 *    Program compiling                                                 *
 *----------------------------------------------------------------------*
C*                                                                      *
 *    @BIODYN    -    creates object and listings - BIODYN.lis          *
 *                                                                      *
C*----------------------------------------------------------------------*
C*    Program Linking on VAX/VMS                                        *
 *----------------------------------------------------------------------*
 *                                                                      *
C*    @BIODYN.LNK                                                       *
 *                                                                      *
 *----------------------------------------------------------------------*
C*    Report any Bugs in this Space                                     *
 *----------------------------------------------------------------------*
 *                                                                      *
 *                                                                      *
 *                                                                      *
 *                                                                      *
 *                                                                      *
 *----------------------------------------------------------------------*
 *    Program Development History                                       *
 *----------------------------------------------------------------------*
 *                                                                      *
 *    Program Creation Date and Author:                                 *
 *        Version 1.0 - 10 MAR 1992    - BIODYN                         *
 *                    - George Roddan, BC Research                      *
 *                                                                      *
************************************************************************
```

```
C*                                                                        *
*     Program Modifications:                                              *
C*                                                                        *
C*    Version      Date         Author/Firm        Description            *
*                                                                         *

C***********************************************************************
C***                        Module #1                              ***
***   Parameter Statements for User Constants and Array Dimensions   ***
C***********************************************************************
C
      IMPLICIT       NONE

      INTEGER*4      LIMA
      PARAMETER      ( LIMA = 262144 )

C***********************************************************************
C***                        Module #2                         ********
***  Explicit Type Declarations for all Variables and Arrays   ********
C***********************************************************************
C
      INTEGER*4      LUCIN, LUCOUT, LULIST, ISTATUS
      INTEGER*4      NUMBER_OF_CYCLES, I_CYCLE, N11, N22
      REAL*4         VERSION_NUMBER
      CHARACTER*32   PROGRAM_NAME

      INTEGER*4      I, IER, IERR, IFIL, IFIRH, IFORR, IRESAM, ITREND, N
C
      REAL*4         A, DEL, DMEAN, FL, FP, FPD, FT1, FT2, FU, HWIN
      REAL*4         TR, TREND1, TREND2, X1, SUM, SMEAN
C
      REAL*8         A0, A1, A2

      COMPLEX        C, CHWIN
C
      CHARACTER*16   DATA_X, DATA_Y, UNITS_X, UNITS_Y

      LOGICAL        INVALID

      DIMENSION      A(LIMA), C(LIMA/2), CHWIN(LIMA/2), HWIN(LIMA)
C
C***********************************************************************
C***          Module #3          ***************************************
C***  Initialize GEDAP System    ***************************************
C***********************************************************************

      PROGRAM_NAME = 'BIODYN'
      VERSION_NUMBER = 1.0
      CALL OPEN_GEDAP_NOLIST ( PROGRAM_NAME, VERSION_NUMBER,
     +                         LUCIN, LUCOUT )
C
C-----------------------------------------------------------------------
C     Obtain the Number of Program Cycles
C-----------------------------------------------------------------------
C
      NUMBER_OF_CYCLES = 1
      CALL PAR_INTEGER_DEFAULT ('number of program cycles [1]',
     +                           NUMBER_OF_CYCLES )
C
C***********************************************************************
C***                Module #4                ***********************
C***  Open GEDAP Input and Output File Streams  ***********************
C***********************************************************************
```

```
C
      CALL PRINT_MESSAGE ( ' ' )

      CALL OPEN_INPUT_FILE_STREAM ( 1, 'input file containing'//
     +                                 ' time series',ISTATUS )
      IF (ISTATUS .NE. 0) CALL CLOSE_GEDAP ( ISTATUS )
C
      CALL PRINT_MESSAGE ( ' ' )

      CALL OPEN_OUTPUT_FILE_STREAM ( 1, 'output file containing'//
     +                                ' filtered time series', ISTATUS )
      IF (ISTATUS .NE. 0) CALL CLOSE_GEDAP ( ISTATUS )

      CALL PRINT_MESSAGE ( ' ' )

***********************************************************************
C***                        Module #5                          ********
C***  Read Conversational Input Data using PAR_xxx Subroutines  ********
***********************************************************************
*
C*--------------------------------------------------------------------*
*    Enter Frequency Weighting as per bio-dynamic model                *
*---------------------------------------------------------------------*
C
      INVALID = .TRUE.
      DO WHILE ( INVALID )
         CALL PRINT_MESSAGE ('Bio-dynamic Modelling Options: ')
         CALL PRINT_MESSAGE ('    0 - Payne - Spinal (DRI)')
         CALL PRINT_MESSAGE ('    1 - Payne - Visceral')
         CALL PRINT_MESSAGE ('    2 - Body Vibration Model')
C        CALL PRINT_MESSAGE ('    3 - Griffin & Fairlea')
         CALL PAR_INTEGER (' Option', IFIRH )
         IF (IFIRH.LT.0 .OR. IFIRH.GT.3) THEN
            CALL PRINT_MESSAGE (' Invalid weighting option ')
         ELSE
            INVALID = .FALSE.
         ENDIF
      END DO

      CALL PRINT_MESSAGE ( ' ' )
C
C*--------------------------------------------------------------------*
*    Enter output sampling option                                      *
*---------------------------------------------------------------------*
C
      INVALID = .TRUE.
      DO WHILE ( INVALID )
         CALL PRINT_MESSAGE (' RESAMPLING OPTION -- ')
         CALL PRINT_MESSAGE ('    IF 0, SAMPLE SPACING OF OUTPUT ='//
     +                       ' SAMPLE SPACING OF INPUT')
         CALL PRINT_MESSAGE ('    IF 1, SAMPLE SPACING OF OUTPUT'//
     +                       ' CONTROLLED BY FFT')
         IRESAM = 0
         CALL PAR_INTEGER_DEFAULT ('resampling option [0]', IRESAM )
         IF (IRESAM.LT.0 .OR. IRESAM.GT.1) THEN
            CALL PRINT_MESSAGE ('Invalid resampling option')
         ELSE
            INVALID = .FALSE.
         ENDIF
      END DO

      CALL PRINT_MESSAGE ( ' ' )
```

```
C*-----------------------------------------------------------------*

C*-----------------------------------------------------------------*
C*****************************************************************
***   S T A R T   O F   M A I N   R E C Y C L I N G   L O O P   *******
*****************************************************************
C*
      I_CYCLE = 1
      DO WHILE ( I_CYCLE .LE. NUMBER_OF_CYCLES )
C
C*****************************************************************
***                Module #6            ******************************
C***   Read Data from GEDAP Input File   ******************************
C*****************************************************************

      CALL READ_GEDAP_1 ( 1, LIMA, DEL, X1, N, A, DATA_X, UNITS_X,
     +                    DATA_Y, UNITS_Y, ISTATUS )
      IF (ISTATUS .NE. 0) CALL CLOSE_GEDAP ( ISTATUS )

C*-----------------------------------------------------------------*
C***       U S E R   C O D E   S T A R T S   H E R E              ***
*------------------------------------------------------------------*

C*-----------------------------------------------------------------*
C*    Remove mean (always done)                                    *
 *                                                                 *
C*-----------------------------------------------------------------*
C
 2222 CONTINUE

         SUM=0.
         DO I=1,N
            SUM=A(I)+SUM
         END DO
         SMEAN=SUM/N
C*-----------------------------------------------------------------*
         DO I=1,N
            A(I) = A(I) - SMEAN
         END DO
C
C*-----------------------------------------------------------------*
C*                                                                 *
C*       APPLY FREQUENCY WEIGHTING                                 *
C*                                                                 *
C*-----------------------------------------------------------------*
C
       CALL FLTV(LUCOUT,A,C,N,LIMA,FL,FU,DEL,FT1,FT2,IRESAM,IFIRH,
     +           HWIN,CHWIN,IFORR,IER)
C
C*****************************************************************
C *Throw away first and last 2% of record to avoid filter end effects *
C*****************************************************************
      N11= .02*N
      N22= .98*N
       N=N22-N11+1
      DO I=1,N
         A(I)=A(I+N11)
      END DO
C
C*****************************************************************
C***               Module #7            ******************************
C***   Write Data to GEDAP Output File   ******************************
C*****************************************************************
```

```
C
C-----------------------------------------------------------------------
C     Store Parameters in GEDAP Output File Header
C-----------------------------------------------------------------------
C
C
C
C-----------------------------------------------------------------------
C     Write GEDAP Output File
C-----------------------------------------------------------------------
C
      CALL WRITE_GEDAP_1 ( 1, DEL, X1, N, A, DATA_X, UNITS_X, DATA_Y,
     +                 UNITS_Y, PROGRAM_NAME, VERSION_NUMBER, ISTATUS )
      IF (ISTATUS .NE. 0) CALL CLOSE_GEDAP ( ISTATUS )
C
C*********************************************************************
C***  E N D   O F   M A I N   R E C Y C L I N G   L O O P   **********
C*********************************************************************
C*
      I_CYCLE = I_CYCLE + 1
      END DO
C
C*********************************************************************
C***              Module #8               ****************************
C***  Close GEDAP and Terminate Program   ****************************
C*********************************************************************
C
      CALL CLOSE_GEDAP ( 0 )
      CALL EXIT
      END
C
C
C
C
C
C
      SUBROUTINE FLTV ( LUE,A,C,N,LIMA,F1,F2,DT,FT1,FT2,IRESAM,
     .IFIRH,HWIN,CHWIN,IFORR,IER)
C
C*********************************************************************
C***************++++++++++++++++++++++++++++*************************
C****************+                          +************************
C****************+     SUBROUTINE FLTV      +************************
C****************+                          +************************
C***************++++++++++++++++++++++++++++*************************
C*********************************************************************
C*                                                                   *
C*-------------------------------------------------------------------*
C*    SUBROUTINE SUMMARY                                             *
C*-------------------------------------------------------------------*
C*                                                                   *
C*    This routine performs filtering or weighting                   *
C*    of an input time series using a frequency window technique.    *
C*                                                                   *
C*-------------------------------------------------------------------*
C*    SUBROUTINE DESCRIPTION                                         *
C*-------------------------------------------------------------------*
C*                                                                   *
C*    1. Find TN, the length of the wave train, and DF, the frequency *
C*       step size.                                                  *
C*                                                                   *
C*    2. Find K such that N < 2**K < 2**N, where N is the number of  *
C*       sample points in the time series.                           *
C*                                                                   *
C*    3. Resample the input array from size N to size NK             *
```

```
C*        where NK = 2**K.                                              *
C*                                                                      *
C*     4. Determine the appropriate weighting function.                 *
C*        ie., according to British Standard 6841                      *
C*                                                                      *
C*     5. Perform a real to complex FFT on A, with the result           *
C*        being in C.                                                   *
C*                                                                      *
C*     6. Calls the specified weighting subroutine to filter the        *
C*        complex frequency series C.                                   *
C*                                                                      *
C*     7. Perform a complex to real FFT on C, with the result           *
C*        being in A.                                                   *
C*                                                                      *
C*     8. Optionally perform resampling on the filtered wave train.     *
C*        If resampling is not performed, then reset DT and N.          *
C*                                                                      *
C*     9. Return to main program.                                       *
C*                                                                      *
C*----------------------------------------------------------------------*
C*    INPUT PARAMETERS                                                  *
C*----------------------------------------------------------------------*
C*                                                                      *
C*    LUE    - logical unit number for output                           *
C*    A      - input time series to filtered                            *
C*    C      - dummy complex array used for working storage. It should  *
C*             be equivalenced in the main program to the array A.      *
C*    N      - number of elements of input time series A                *
C*    LIMA   - dimensioned size of the array                            *
C*    F1     - lower cutoff frequency in Hz                             *
C*    F2     - upper cutoff frequency in Hz                             *
C*    FT1    - lower transition frequency band                          *
C*    FT2    - upper transition frequency band                          *
C*    DT     - intersample spacing of input time series A, in seconds   *
C*    IRESAM - switch which controls resampling option                  *
C*    IFIRH  - filter option switch                                     *
C*    HWIN   - ema array where the hamming window coefficients  are     *
C*             stored for the hamming filter routine                    *
C*    CHWIN  - complex working array of hamming window coefficients     *
C*    IFORR  - output debug option                                      *
C*                                                                      *
C*----------------------------------------------------------------------*
C*    OUTPUT PARAMETERS                                                 *
C*----------------------------------------------------------------------*
C*                                                                      *
C*    A      - filtered time series                                     *
C*    N      - number of elements of input time series A                *
C*    DT     - intersample spacing of filtered time series              *
C*    LUE    - retained to maintain calling sequence                    *
C*                                                                      *
C*----------------------------------------------------------------------*
C*    LOCAL VARIABLES                                                   *A
C*----------------------------------------------------------------------*
C*                                                                      *
C*    TN     - length of wave train (N*DT)                              *
C*    DF     - frequency step size (1/TN)                               *
C*    NK     - the size of the resampled time series. NK must be a      *
C*             power of two and satisfy the conditions                  *
C*                         NK <= LIMA                                   *
C*                         NK >= N                                      *
C*                                                                      *
C*----------------------------------------------------------------------*
C*    SUBROUTINES CALLED:                                               *
```

```
C*-----------------------------------------------------------------------*
C*                                                                       *
C*    EQUIV_CMPLX_TO_REAL - converts COMPLEX to REAL*4, REAL*4           *
C*                                                                       *
C*    EQUIV_REAL_TO_CMPLX - converts ( REAL*4, REAL*4 ) to COMPLEX       *
C*                                                                       *
C*    FBRIT  - filters a complex frequency array using                   *
C*             a specified transfer function                             *
C*                                                                       *
C*    FCOEF  - converts a complex frequency array into a real            *
C*            frequency array                                            *
C*                                                                       *
C*    FFTCM  - complex to real scale and reorder                         *
C*                                                                       *
C*    FFTEM  - complex to complex FFT                                    *
C*                                                                       *
C*    FFTRM  - real to complex scale and reorder                         *
C*                                                                       *
C*    ESIZN  - resamples an array to a desired larger size               *
C*                                                                       *
C*    TWLOG  - finds NK such that the conditions are satisfied           *
C*                                                                       *
C*=======================================================================*
C*                                                                       *
C*    Programmed by: D. Loewen and E. Funke                              *
C*    For Hydraulics Laboratory                                          *
C*        National Research Council                                      *
C*        Ottawa                                                         *
C*    April 1983                                                         *
C*    Version 1.0                                                        *
C*                                                                       *
C************************************************************************
C*                                                                       *
C*    Subroutine Modifications:                                          *
C*                                                                       *
C*    Version      Date         Author/Firm      Description             *
C*      1.0     27 NOV 1991      George Roddan   Frequency Weighting     *
C*                               BCR             Brit. Stan. 6841        *
C*-----------------------------------------------------------------------*
C*  Converted to VAX/VMS Version 2  8 Dec 1987    Tyson Haedrich/NRC     *
C*-----------------------------------------------------------------------*
C*                                                                       *
C************************************************************************
C
      IMPLICIT    NONE
C
      INTEGER*4   IER, IFIRH, IFORR, IRESAM, K, LIMA, LUE, MK, N, NK
C
      REAL*4      A, DF, DT, F1, F2, FT1, FT2, HWIN, TN
C
      COMPLEX     C, CHWIN
C
      DIMENSION   A(LIMA), C(LIMA/2), CHWIN(LIMA/2), HWIN(LIMA)
C
C*    Find the length of the wave train and the frequency step size      *
C
      TN = N*DT
      DF = 1/TN
C
C*    Find K such that N < 2**K < 2*N                                    *
C
      CALL TWLOG(N,262144,K,NK)
      IF (2*N .EQ. NK) THEN
```

```
           NK = N
           K  = K - 1
        ENDIF
        IF (NK .GT. LIMA) THEN
           CALL ERROR_MESSAGE (1,2,'FLTA','Resampled time series'//
     +                        ' larger than array A',' ',' ')
           CALL CLOSE_GEDAP ( -1 )
        ENDIF
C
C*      Resample the input array                                       *
C
        CALL ESIZN(A,N,NK)
C
C*      Perform real to complex FFT on A                               *
C
        MK = K - 1
C
        CALL EQUIV_REAL_TO_CMPLX ( A, C, LIMA )
C
        CALL FFTEM(C,MK,-1)
        CALL FFTRM(C,NK)
C
        CALL EQUIV_CMPLX_TO_REAL ( A, C, LIMA )
C
C*---------------------------------------------------------------------*
C*      Weight the complex frequency array using the user specified    *
C*      filter weighting.                                              *
C*---------------------------------------------------------------------*
C
                    CALL EQUIV_REAL_TO_CMPLX ( A, C, LIMA )
                    CALL FBRIT(LUE,C,DF,NK,IFIRH,IER)
                    CALL EQUIV_CMPLX_TO_REAL ( A, C, LIMA )
C
C*---------------------------------------------------------------------*
C*      Perform a complex to real FFT on C                             *
C*---------------------------------------------------------------------*
C
        CALL EQUIV_REAL_TO_CMPLX ( A, C, LIMA )
C
        CALL FFTCM(C,NK)
        CALL FFTEM(C,MK,1)
C
        CALL EQUIV_CMPLX_TO_REAL ( A, C, LIMA )
C
C*---------------------------------------------------------------------*
C*      Optionally perform resampling on resultant wave train. If     *
C*      resampling not performed then reset DT and N                   *
C*---------------------------------------------------------------------*
C
        IF (IRESAM .EQ. 0)  THEN
           CALL ESIZN(A,NK,N)
        ELSE
           DT = TN/NK
           N  = NK
        ENDIF
C
        RETURN
***********************************************************************
                              END
***********************************************************************
```


DEC/CMS REPLACEMENT HISTORY, Element FILTA.FOR

```
C***********************************************************************
C**************************BIO******************************************
C***********************************************************************
C
C     Subroutine library for the program &BIODYN
C
C***********************************************************************
C***********************************************************************
C
C----------------------------------------------------------------------
C     Converted to GEDAP Version II
C----------------------------------------------------------------------
C
C*---------------------------------------------------------------------*
C
C
      SUBROUTINE FBRIT (LUE,C,DELF,NK,IFIRH,IER)
C
C***********************************************************************
C***************+++++++++++++++++++++++++********************************
C***************+                         +*****************************
C***************+    SUBROUTINE FBRIT     +*****************************
C***************+                         +*****************************
C**************+++++++++++++++++++++++++*********************************
C***********************************************************************
C*                                                                     *
C*---------------------------------------------------------------------*
C*    SUBROUTINE SUMMARY                                               *
C*---------------------------------------------------------------------*
C*                                                                     *
C*    SELECT FREQUENCY WEIGHTING AND FILTER IN THE FREQUENCY DOMAIN    *
C*    ACCORDING TO PREDEFINED BIODYNAMIC MODEL.                        *
C*                                                                     *
C*---------------------------------------------------------------------*
C*    SUBROUTINE DESCRIPTION:                                          *
C*---------------------------------------------------------------------*
C*                                                                     *
C*    BASICALLY PERFORMS BAND-PASS FILTERING IN THE FREQUENCY DOMAIN   *
C*                                                                     *
C*    Compile instructions - @BIO - then this is linked to BIODYN      *
C*                                using @BIODYN.LNK                    *
C*---------------------------------------------------------------------*
C*    INPUT PARAMETERS                                                 *
C*---------------------------------------------------------------------*
C*                                                                     *
C*    LUE    - logical unit number for error messages                  *
C*    C      - complex frequency array (of A), to be filtered          *
C*    DELF   - intersample spacing of the freqency array               *
C*    NK     - number of elements in the resamples array A             *
C*    IFIRH  - integer code which determines which weighting function  *
C*                                                                     *
C*---------------------------------------------------------------------*
C*    OUTPUT PARAMETERS                                                *
C*---------------------------------------------------------------------*
C*                                                                     *
C*    IER    - an error indicator                                      *
C*    C      - filtered frequency array                                *
C*                                                                     *
C*---------------------------------------------------------------------*
C*    LOCAL VARIABLES                                                  *
C*---------------------------------------------------------------------*
C*                                                                     *
C*    NK            - number of elements in the complex freq. array C  *
```

```
C*                                                                     *
C*---------------------------------------------------------------------*
C*    SUBROUTINES AND FUNCTIONS CALLED:                                *
C*---------------------------------------------------------------------*
C*                                                                     *
C*---------------------------------------------------------------------*
C*                                                                     *
C*    Subroutine Creation Date and Author:                             *
C*        Version 1.0 - 28 Nov. 1991                                   *
C*                    - George Roddan, BC                              *
C*                                                                     *
C*---------------------------------------------------------------------*
C*                                                                     *
C*    Subroutine Modifications:                                        *
C*                                                                     *
C*    Version             Date                 Author/Firm             *
C*      1.0              9 Dec 1991           George Roddan/bcr        *
C*                                                                     *
C*      2.0              3 Feb 1992           George Roddan/bcr        *
C*                                                                     *
C*      3.0             11 Mar 1992           George Roddan/bcr        *
C*                                                                     *
C*                                                                     *
C*    Description:  This module has been updated to reflect the        *
C*                  current GEDAP program standards.                   *
C*                                                                     *
C***********************************************************************
C
      IMPLICIT     NONE
C
      INCLUDE  'G2$:GGP.FOR'
C
      CHARACTER*32 FILTER_TYPE
C
      INTEGER*4    I, IFIRH, IER, LUE, N1, N2, N3, N4, NK, NKH,N1MAX
C     INTEGER*4    N5
C
      REAL*4       DELF, A1, B1, C1, D1, E1, G1, FT1, FT2, PI
      REAL*4       F1, F2, F3, F4, F5, F6, Q1, Q2, Q3, Q4, K, W
      REAL*4       TPI, FPI, H, R1
C
      COMPLEX      C, H1, S, Z1, Z2

      DIMENSION    C(131072), H1(131072)
C
      PARAMETER    ( PI = 3.141592654 )
C
      NKH = NK/2 + 1
      TPI = 2.*PI
      FPI = 4.*PI**2.
C
C*---------------------------------------------------------------------*
C*    First define the frequency weighting array
C*********************************************************************
C****************** Payne Spinal Model ******************************
C*********************************************************************
C
      IF (IFIRH .EQ. 0) THEN
         F1 = 52.9      ! rad/sec , undamped natural freq.
         R1 = .224      ! damping ratio
         FILTER_TYPE = ' Payne - Spinal'
         Call PUT_CHARACTER_PARAMETER ('FILTER_TYPE',FILTER_TYPE)
         GO TO 50
```

```
      ENDIF

C
C*********************************************************************
C****************** Payne Visceral Model***************************
C*********************************************************************
C
      IF (IFIRH .EQ. 1) THEN
         F1 = 25.1       ! rad/sec , undamped natural freq.
         R1 = .400       ! damping ratio
         FILTER_TYPE = ' Payne - Visceral'
         Call PUT_CHARACTER_PARAMETER ('FILTER_TYPE',FILTER_TYPE)
         GO TO 50
      ENDIF
C
C*********************************************************************
C*********************** Body Vibration Model **********************
C*********************************************************************
C
      IF (IFIRH .EQ. 2) THEN
         F1 = 52.9       ! rad/sec , undamped natural freq.
         R1 = 1.00       ! damping ratio
         FILTER_TYPE = ' Body - Vibration'
         Call PUT_CHARACTER_PARAMETER ('FILTER_TYPE',FILTER_TYPE)
         GO TO 50
      ENDIF

C
C*********************************************************************
C*********************** Griffin & Fairlea *************************
C*********************************************************************
C
      IF (IFIRH .EQ. 3) THEN
         F1 = 31.42       ! rad/sec , undamped natural freq.
         R1 = 0.475      ! damping ratio
         FILTER_TYPE = ' Griffin & Fairlea '
         Call PUT_CHARACTER_PARAMETER ('FILTER_TYPE',FILTER_TYPE)
         GO TO 50
      ENDIF

C
C*********************************************************************
C*********************************************************************
C************** Calculate Complex Transfer Function ****************
C*********************************************************************
C*********************************************************************
C
50       DO I = 1,NKH
             W=TPI*FLOAT(I)*DELF
             S=cmplx(0.0,W)
             Z1 = F1**2. + S*2.0*R1*F1
             Z2 = F1**2. + S*2.0*R1*F1 + S**2
C
             H1(I)= (Z1)/(Z2)
C
         END DO
C
C*-------------------------------------------------------------------*
C*   Filter the signal in the frequency domain                       *
C*-------------------------------------------------------------------*
C
100   DO I= 1, NKH
         C(I) = C(I)*H1(I)
```

```
      END DO
      GO TO 200
C
C*-------------------------------------------------------------------------*
C*-------------------------------------------------------------------------*
200   RETURN
C
C*-------------------------------------------------------------------------*
      END
C*-------------------------------------------------------------------------*
C
C
C
C
      SUBROUTINE FCOEF (A,C,N,NK,DELF,DEL)
C
C************************************************************************
C**************+++++++++++++++++++++++++++++++++*************************
C**************+                              +*************************
C**************+    SUBROUTINE FCOEF          +*************************
C**************+                              +*************************
C**************+++++++++++++++++++++++++++++++++*************************
C************************************************************************
C*                                                                      *
C*----------------------------------------------------------------------*
C*    SUBROUTINE SUMMARY                                                *
C*----------------------------------------------------------------------*
C*                                                                      *
C*    Subroutine used to convert a complex frequency array into         *
C*    'real' frequency array.                                           *
C*                                                                      *
C*----------------------------------------------------------------------*
C*    SUBROUTINE DESCRIPTION                                            *
C*----------------------------------------------------------------------*
C*                                                                      *
C*    Subroutine used to convert a complex frequency array into         *
C*    a 'real' frequency array.                                         *
C*                                                                      *
C*----------------------------------------------------------------------*
C*    INPUT PARAMETERS                                                  *
C*----------------------------------------------------------------------*
C*                                                                      *
C*    C       - complex frequency array                                 *
C*    DELF    - intersample spacing of frequency array                  *
C*    NK      - number of elements in array C                           *
C*                                                                      *
C*----------------------------------------------------------------------*
C*    OUTPUT PARAMETERS                                                 *
C*----------------------------------------------------------------------*
C*                                                                      *
C*    A       - absolute value frequency array                          *
C*    N       - number of elements in array A                           *
C*                                                                      *
C*----------------------------------------------------------------------*
C*    SUBROUTINES AND FUNCTIONS CALLED:                                 *
C*----------------------------------------------------------------------*
C*                                                                      *
C*    none                                                              *
C*                                                                      *
C*----------------------------------------------------------------------*
C*                                                                      *
C*    Subroutine Creation Date and Author:                              *
C*        Version 1.0 - 23 Dec. 1983                                    *
```

```
C*                    - Don G. Smith, DMR                               *
C*                                                                      *
C*----------------------------------------------------------------------*
C*                                                                      *
C*    Subroutine Modifications:                                         *
C*                                                                      *
C*    Version             Date                  Author/Firm             *
C*      1.0           23 Dec. 1983           Don G. Smith/DMR           *
C*                                                                      *
C*    Description:  Original                                            *
C*                                                                      *
C*      1.1           22 Jan. 1985           Harold Chard/DMR           *
C*                                                                      *
C*    Description:  This module has been updated to reflect the         *
C*                  current GEDAP program standards.                    *
C*                                                                      *
C***********************************************************************
C
      IMPLICIT        NONE
C
      INTEGER*4       I, N, NK
C
      REAL*4          A, DEL, DELF
C
      COMPLEX         C
C
      DIMENSION       A(*), C(*)
C
      N =NK
      DEL = DELF
      DO I = 1,NK
          A(I) = CABS(C(I))
      END DO
C
      RETURN
C
C*----------------------------------------------------------------------*
      END
! DEC/CMS REPLACEMENT HISTORY, Element FILTALIB.FOR
! *1     2-NOV-1987 09:15:50 ALGONQUIN "Low and high pass filtering on a complex frequency arra
, cardinal filter."
! DEC/CMS REPLACEMENT HISTORY, Element FILTALIB.FOR
```

Program CREST3.FOR

```
      PROGRAM CREST3
C
C-----------------------------------------------------------------------
C   Program Description
C-----------------------------------------------------------------------
C  This program calculates the various statistical values such as RMQ,
C  RMX, RMO, RMD as well as their dose values from a weighted acceleration
C  record. It also calculates crest factor based on (MAX-MIN)/2.
C  The program will also calculate Max DRI when used in conjuction with
C  DRI model
C-----------------------------------------------------------------------
C   Definition of GEDAP Data Files
C-----------------------------------------------------------------------
C
C
C-----------------------------------------------------------------------
C   Development History
C-----------------------------------------------------------------------
C
C   Version 3.0 by George Roddan & Brian Remedios (BCR)       04-Feb-1992
C   Version 3.1 by George Roddan (BCR) Max DRI calc added     02-Mar-1992
C***********************************************************************
C
C  To compile this program type @crest3, to link type @crest3.lnk
C
C=======================================================================
C     Parameter Statements for User Constants and Array Dimensions
C=======================================================================
C
      IMPLICIT    NONE
C
      INTEGER*4   N_max, NUMBER_OF_CYCLES, I_CYCLE
      REAL*4      PI
      PARAMETER  (PI = 3.141593, N_max = 262144)
C
C=======================================================================
C     Explicit Type Declarations for all Variables and Arrays
C=======================================================================
C
      INTEGER*4     LUCIN, LUCOUT, N, I, L1, L2, ISTATUS, COUNT
C
      LOGICAL       PAF
      REAL*4        DX, X1, VERSION_NUMBER, Y(N_max), KURT
      REAL*4        MAX, RMS, CREST_FACTOR, eVDV, VDV, Ts
C
C ---New additions since version 1.0-----------------------------------
C
      REAL*4        SUM, RMQ, RMX, RMO, RMT, RMTT
      REAL*4        VXV, VOV, VTV, VRV, VTTV, MIN
      REAL*4        DAS_DEL, SAMPLE_RATE, MAX_DRI
C
C-----------------------------------------------------------------------
C
      CHARACTER*16  DATA_X, DATA_Y, UNITS_X, UNITS_Y
      CHARACTER*32  PROGRAM_NAME
      CHARACTER*80  INPUT_FILE, OUTPUT_FILE, CORE_NAME,
     +              DEFAULT_OUTPUT_FILE, FILE_TYPE, PAF_FILE
      CHARACTER*80  FILE_NAME
C
C=======================================================================
C     Initialize GEDAP System
C=======================================================================
```

```
      PROGRAM_NAME    = 'CREST3'
      VERSION_NUMBER  = 3.0
      CALL OPEN_GEDAP_NOLIST ( PROGRAM_NAME, VERSION_NUMBER,
     +                         LUCIN, LUCOUT )
C
C=========================================================================
C     Obtain the number of Program Cycles
C=========================================================================
      NUMBER_OF_CYCLES = 1
      CALL PAR_INTEGER_DEFAULT ('number of program cycles [1]',
     +                          NUMBER_OF_CYCLES )
C=========================================================================
C     Open GEDAP Input and Output File Streams
C=========================================================================
C
      CALL PRINT_MESSAGE ('    ')
C
      CALL OPEN_INPUT_FILE_STREAM ( 1, 'input file containing'//
     +                              ' time series',ISTATUS )
      IF (ISTATUS .NE. 0) CALL CLOSE_GEDAP ( ISTATUS )
C
      CALL PRINT_MESSAGE ('    ')
C
      CALL OPEN_OUTPUT_FILE_STREAM ( 1, 'output file containing'//
     +                               ' time series' , ISTATUS )
      IF (ISTATUS .NE. 0 ) CALL CLOSE_GEDAP ( ISTATUS )
C
      CALL PRINT_MESSAGE ('    ')
C
      CALL PAR_CHAR ( 'name of time series input file [.001]',
C    +                INPUT_FILE )
C     CALL DEFAULT_FILE_TYPE ( INPUT_FILE )
C
      CALL PARSE_FILE_SPEC ( INPUT_FILE, CORE_NAME, L1,
C    +                       FILE_TYPE, L2 )
C     DEFAULT_OUTPUT_FILE = CORE_NAME(1:L1) // '_CREST' //
C    +                      FILE_TYPE(1:L2)
C     L1 = L1 + L2 + 6
C     CALL PAR_CHAR ( 'name of output file ['//
C    +                DEFAULT_OUTPUT_FILE(1:L1)//']', OUTPUT_FILE )
C     IF ( OUTPUT_FILE .EQ. ' ' ) THEN
C        OUTPUT_FILE = DEFAULT_OUTPUT_FILE(1:L1)
C     END IF
C
C     CALL OPEN_INPUT_FILE_STREAM_1 ( 1, INPUT_FILE, ISTATUS )
C     IF (ISTATUS .NE. 0) CALL CLOSE_GEDAP ( ISTATUS )
C
C     CALL OPEN_OUTPUT_FILE_STREAM_1 ( 1, OUTPUT_FILE, ISTATUS )
C     IF (ISTATUS .NE. 0) CALL CLOSE_GEDAP ( ISTATUS )
C
C=========================================================================
C Read Conversational Input Parameters using subroutines PAR_REAL,
C PAR_INTEGER, PAR_CHAR, etc.
C=========================================================================
C
C=========================================================================
C    Read data from a GEDAP type V1 input file into array Y
C=========================================================================
     I_CYCLE = 1
     DO WHILE ( I_CYCLE .LE. NUMBER_OF_CYCLES )

C*************************************************************************
     CALL READ_GEDAP_1 ( 1, N_max, DX, X1, N, Y,
```

```
     +                          DATA_X, UNITS_X, DATA_Y, UNITS_Y, ISTATUS)
      IF ( ISTATUS .NE. 0) CALL CLOSE_GEDAP ( ISTATUS )
      CALL GET_INPUT_FILE (1,FILE_NAME)
      CALL PARSE_FILE_SPEC (FILE_NAME, CORE_NAME, L1,
     +FILE_TYPE, L2)
C
C===========================================================================
C **********    U S E R   C O D E   S T A R T S   H E R E    **********
C===========================================================================
C
      CALL FETCH_REAL_PARAMETER ( 'STAT_MAX', MAX )
      CALL FETCH_REAL_PARAMETER ( 'STAT_MIN', MIN )
      CALL FETCH_REAL_PARAMETER ( 'STAT_STD_DEV', RMS )
      CALL FETCH_REAL_PARAMETER ( 'STAT_KURTOSIS',KURT )
C
      CREST_FACTOR = ((MAX-MIN)/2.) / RMS
                Ts = N * DX
        eVDV = (( 1.4 * RMS)**4.0 *Ts)**.25   ! estimated vib. dose
         VDV = (Ts * KURT)**.25 * RMS          ! dose based on rmq
         VRV = (Ts)**.5*RMS                    ! dose based on rms

C  Calculate the sample rate from the period
C
      CALL FETCH_REAL_PARAMETER ('DAS_DEL',DAS_DEL)
      SAMPLE_RATE = 1/DAS_DEL
C
      SUM = 0
      DO COUNT=1,N
        SUM = SUM + (Y(COUNT)**4)
      END DO
      RMQ = (SUM/N) ** (1.0/4.0)
C     VDV already defined above

      SUM = 0
      DO COUNT=1,N
        SUM = SUM + (Y(COUNT)**6)
      END DO
      RMX = (SUM/N) ** (1.0/6.0)
      VXV = (RMX)*(Ts)** (1.0/6.0)  ! dose based on rmx

      SUM = 0
      DO COUNT=1,N
        SUM = SUM + (Y(COUNT)**8)
      END DO
      RMO = (SUM/N) ** (1.0/8.0)
      VOV = (RMO)*(Ts)** (1.0/8.0)  ! dose based on rmo

      SUM = 0
      DO COUNT=1,N
         SUM = SUM + (Y(COUNT)**10)
      END DO
      RMT = (SUM/N) ** (1.0/10.0)
      VTV = (RMT)*(Ts)** (1.0/10.0) ! dose based on rmd


      SUM = 0
      DO COUNT=1,N
         SUM = SUM + (Y(COUNT)**12)
      END DO
      RMTT = (SUM/N) ** (1.0/12.0)
      VTTV = (RMTT)*(Ts)** (1.0/12.0) ! dose based on rmtt
C
      MAX_DRI = MAX*285.55             ! Max DRI assumes units are metric
```

```
                                    ! and Payne spinal model only.
C==========================================================================
C  Store parameters in B-Header using subroutines PUT_REAL_PARAMETER,
   PUT_INTEGER_PARAMETER and PUT_CHARACTER_PARAMETER.     (Optional)
C==========================================================================
C

      CALL PUT_REAL_PARAMETER ( 'CREST_FACTOR', CREST_FACTOR )
      CALL PUT_REAL_PARAMETER ( 'eVDV', eVDV )
      CALL PUT_REAL_PARAMETER ( 'VDV', VDV )
      CALL PUT_REAL_PARAMETER ( 'Ts', Ts )
      CALL PUT_REAL_PARAMETER ( 'RMQ', RMQ)
      CALL PUT_REAL_PARAMETER ( 'RMX', RMX)
      CALL PUT_REAL_PARAMETER ( 'RMO', RMO)
      CALL PUT_REAL_PARAMETER ( 'RMT', RMT)
      CALL PUT_REAL_PARAMETER ( 'RMTT', RMTT)
      CALL PUT_REAL_PARAMETER ( 'VRV', VRV)
      CALL PUT_REAL_PARAMETER ( 'VXV', VXV)
      CALL PUT_REAL_PARAMETER ( 'VOV', VOV)
      CALL PUT_REAL_PARAMETER ( 'VTV', VTV)
      CALL PUT_REAL_PARAMETER ( 'VTTV', VTTV)
      CALL PUT_REAL_PARAMETER ( 'OB_RMQ_RMS', RMQ/RMS)
      CALL PUT_REAL_PARAMETER ( 'OB_RMX_RMS', RMX/RMS)
      CALL PUT_REAL_PARAMETER ( 'OB_RMO_RMS', RMO/RMS)
      CALL PUT_REAL_PARAMETER ( 'OB_RMT_RMS', RMT/RMS)
      CALL PUT_REAL_PARAMETER ( 'OB_RMTT_RMS', RMTT/RMS)
      CALL PUT_REAL_PARAMETER ( 'SAMPLE_RATE', SAMPLE_RATE)
      CALL PUT_REAL_PARAMETER ( 'MAX_DRI', MAX_DRI)

C
C==========================================================================
C     Write data from array Y into a GEDAP type V1 output file
C==========================================================================

      CALL WRITE_GEDAP_1 ( 1, DX, X1, N, Y, DATA_X, UNITS_X, DATA_Y,
     + UNITS_Y, PROGRAM_NAME, VERSION_NUMBER, ISTATUS )
C
      IF ( ISTATUS .NE. 0) CALL CLOSE_GEDAP ( ISTATUS )
C==========================================================================
C    Add new parameters to the parameter Accumulation File
C==========================================================================

      CALL OPEN_ACCUMULATE (FILE_TYPE(1:L2), PAF, PAF_FILE)
      IF (PAF) THEN

      CALL PUT_REAL_PARAMETER ( 'CREST_FACTOR', CREST_FACTOR )
      CALL PUT_REAL_PARAMETER ( 'eVDV', eVDV )
      CALL PUT_REAL_PARAMETER ( 'VDV', VDV )
      CALL PUT_REAL_PARAMETER ( 'Ts', Ts )
      CALL PUT_REAL_PARAMETER ( 'RMQ', RMQ)
      CALL PUT_REAL_PARAMETER ( 'RMX', RMX)
      CALL PUT_REAL_PARAMETER ( 'RMO', RMO)
      CALL PUT_REAL_PARAMETER ( 'RMT', RMT)
      CALL PUT_REAL_PARAMETER ( 'RMTT', RMTT)
      CALL PUT_REAL_PARAMETER ( 'VRV', VRV)
      CALL PUT_REAL_PARAMETER ( 'VXV', VXV)
      CALL PUT_REAL_PARAMETER ( 'VOV', VOV)
      CALL PUT_REAL_PARAMETER ( 'VTV', VTV)
      CALL PUT_REAL_PARAMETER ( 'VTTV', VTTV)
      CALL PUT_REAL_PARAMETER ( 'OB_RMQ_RMS', RMQ/RMS)
      CALL PUT_REAL_PARAMETER ( 'OB_RMX_RMS', RMX/RMS)
      CALL PUT_REAL_PARAMETER ( 'OB_RMO_RMS', RMO/RMS)
```

```
      CALL PUT_REAL_PARAMETER   OB_RMT_RMS', RMT/RMS)
      CALL PUT_REAL_PARAMETER ( 'OB_RMTT_RMS', RMTT/RMS)
      CALL PUT_REAL_PARAMETER ( 'SAMPLE_RATE', SAMPLE_RATE)
      CALL PUT_REAL_PARAMETER ( 'MAX_DRI', MAX_DRI)


      CALL CLOSE_ACCUMULATE (PAF_FILE)
      ENDIF
C======================================================================
C**     END  OF  MAIN  RECYCLING  LOOP
C======================================================================
      I_CYCLE = I_CYCLE + 1
      END DO
C======================================================================
C     Close GEDAP and Terminate Program
C======================================================================
C
      CALL CLOSE_GEDAP (0)
      CALL EXIT
      END
```

Program IMPULSE.FOR

```
C----------------------------------------------------------------------
 ----------------------------------------------------------------------

      PROGRAM IMPULSE
C
 ----------------------------------------------------------------------
C    Program Description
C----------------------------------------------------------------------

  This program calculates impulsiveness measures for a number of
C different cumulative probability levels.
C
 ----------------------------------------------------------------------
C Progam Linking on VAX/VMS
C----------------------------------------------------------------------

  $ Link IMPULSE,G2$:DSP/L,GEDAP/L
C
 ----------------------------------------------------------------------
    Definition of GEDAP Data Files
C----------------------------------------------------------------------
C
    Input File: DENS_CDH,    Cumulative Probability Density

C----------------------------------------------------------------------
    Development History
 ----------------------------------------------------------------------
C
C   Version 1.0 by George Roddan (BCR)                    05-Feb-1992
    with code (INTCD) developed by M.D. Miles (NRC)
C
C**********************************************************************

 ======================================================================
C     Parameter Statements for User Constants and Array Dimensions
C======================================================================

      IMPLICIT    NONE
C
      INCLUDE     'G2$:GGP.FOR'

      INTEGER*4   N_max, I, L1, L2, L3
      REAL*4      PI
      PARAMETER  (PI = 3.141593, N_max = GGP$NFFT_MAX )
C
C======================================================================
      Explicit Type Declarations for all Variables and Arrays
C======================================================================
C
      INTEGER*4     I_CYCLE, LUCIN, LUCOUT, N, NUMBER_OF_CYCLES

      REAL*4        VERSION_NUMBER, X(N_max), Y(N_max), ARMS, IM(6)
      Real          PPLUS(6), PMINUS(6), APLUS(6), AMINUS(6)

      CHARACTER*16  DATA_X, DATA_Y, UNITS_X, UNITS_Y
      CHARACTER*32  PROGRAM_NAME, FILE_TYPE
      CHARACTER*80  PAF_FILE, FILE_NAME, CORE_NAME

      LOGICAL   PAF

 ======================================================================
C
C     Data Statements - Defines upper and lower cumulative probability
```

```
C                               levels: 0.99, 0.97, 0.95, 0.93, 0.88, 0.81
                                ( Arranged symmetrically about the mean value )
C=====================================================================

        Data PPlus/0.995, 0.985, 0.975, 0.965, 0.940, 0.905/
        Data PMinus/0.005, 0.015, 0.025, 0.035, 0.060, 0.095/

C=====================================================================
C       Initialize GEDAP System
C=====================================================================
C
        PROGRAM_NAME    = 'IMPULSE'
        VERSION_NUMBER  = 1.0
        CALL OPEN_GEDAP_NOLIST ( PROGRAM_NAME, VERSION_NUMBER,
     +                           LUCIN, LUCOUT )

C---------------------------------------------------------------------
C       Obtain the Number of Program Cycles
C---------------------------------------------------------------------

        NUMBER_OF_CYCLES = 1
        CALL PAR_INTEGER_DEFAULT ( 'number of program cycles [1]',
     +                             NUMBER_OF_CYCLES )
C
C=====================================================================
C       Open GEDAP Input and Output File Streams
C=====================================================================
C
        CALL OPEN_INPUT_STREAM  ( 1, 'name of input file' )
        CALL OPEN_OUTPUT_STREAM ( 1, 'name of output file' )
C
C=====================================================================
C     Read Conversational Input Parameters using subroutines PAR_REAL,
C     PAR_INTEGER, PAR_CHAR, etc.
C=====================================================================


C*********************************************************************
C***   S T A R T   O F   M A I N   R E C Y C L I N G   L O O P   *******
C*********************************************************************
C
        I_CYCLE = 1
        DO WHILE ( I_CYCLE .LE. NUMBER_OF_CYCLES )
C
C=====================================================================
C          Read data from a GEDAP type V2 input file into array Y
C=====================================================================
C
           CALL READ_GEDAP_V2 ( 1, N_max, N, X, Y,
     +                          DATA_X, UNITS_X, DATA_Y, UNITS_Y )
           CALL GET_INPUT_FILE (1, FILE_NAME)
           CALL PARSE_FILE_SPEC (FILE_NAME, CORE_NAME, L1,
     +                           FILE_TYPE, L2)

C
C=====================================================================
C**********   U S E R   C O D E   S T A R T S   H E R E   **********
C=====================================================================
C
C       Fetch parameters

        CALL FETCH_REAL_PARAMETER ( 'STAT_RMS', ARMS )
```

```
C     Calculate Impulsiveness

      DO I = 1,6
            CALL INTP2( Y, X, N, PPLUS(I), APLUS(I))
            CALL INTP2( Y, X, N, PMINUS(I), AMINUS(I))
                 IM(I)=(APLUS(I)-AMINUS(I))/(2.0*ARMS)
      END DO

C
C================================================================
C  Store parameters in B-Header using subroutines PUT_REAL_PARAMETER,
C  PUT_INTEGER_PARAMETER and PUT_CHARACTER_PARAMETER.    (Optional)
C================================================================
C
         CALL PUT_REAL_PARAMETER ('I_99', IM(1) )
         CALL PUT_REAL_PARAMETER ('I_97', IM(2) )
         CALL PUT_REAL_PARAMETER ('I_95', IM(3) )
         CALL PUT_REAL_PARAMETER ('I_93', IM(4) )
         CALL PUT_REAL_PARAMETER ('I_88', IM(5) )
         CALL PUT_REAL_PARAMETER ('I_81', IM(6) )
C
C================================================================
C        Write data from array Y into a GEDAP type V2 output file
C================================================================
C
         CALL WRITE_GEDAP_V2 ( 1, N, X, Y,
     +                         DATA_X, UNITS_X, DATA_Y, UNITS_Y )
C================================================================
C   Add new parameters to the Parameter Accumulation File
C================================================================

       CALL OPEN_ACCUMULATE ( FILE_TYPE(1:L2), PAF, PAF_FILE )
       IF (PAF) THEN

          CALL PUT_REAL_PARAMETER ('I_99', IM(1) )
          CALL PUT_REAL_PARAMETER ('I_97', IM(2) )
          CALL PUT_REAL_PARAMETER ('I_95', IM(3) )
          CALL PUT_REAL_PARAMETER ('I_93', IM(4) )
          CALL PUT_REAL_PARAMETER ('I_88', IM(5) )
          CALL PUT_REAL_PARAMETER ('I_81', IM(6) )

       CALL CLOSE_ACCUMULATE (PAF_FILE)
       ENDIF

C*********************************************************************
C***  E N D   O F   M A I N   R E C Y C L I N G   L O O P  ***********
C*********************************************************************
C
         I_CYCLE = I_CYCLE + 1
       END DO
C
C================================================================
C     Close GEDAP and Terminate Program
C================================================================
C
       CALL CLOSE_GEDAP (0)
       CALL EXIT
       END
```

Program ISO.FOR

```
C-----------------------------------------------------------------
    ISO.FOR  - ANSI 3rd Octave Analysis
-----------------------------------------------------------------
C
      PROGRAM ISO

C-----------------------------------------------------------------
C   Program Description
-----------------------------------------------------------------
  Originally written by Nabibh   (Fort Rucker, AL) for a PC-Based
C data acquisition system, ISO reconfigures spectrum input files according
  to the 3rd octave method described in the ISO standard S1.11-1986.
  This results in a file with an unequal spacing of the X components
C (frequency) and thus must be placed in a V2 data file.
C

  Compile and link this program with I.COM, however if you want to debug
C it first use ND.COM (NoDebug) instead.

-----------------------------------------------------------------
C   Definition of GEDAP Data Files
C-----------------------------------------------------------------

C   ISO.for         - this file (main program)
C   MKFILTER.for    - make filter subroutine
    FILGAIN.for     - gain calculations subroutine
    COMMONS.oct     - common variable listings
C
-----------------------------------------------------------------
    Development History
C-----------------------------------------------------------------
C
    Version 1.0 by Brian Remedios                          Dec 17, 1991

C*****************************************************************

=================================================================
C     Parameter Statements for User Constants and Array Dimensions
C================================================================

      IMPLICIT    NONE
C
      include 'COMMONS.OCT'
      INTEGER*4    N_max
      REAL*4       PI
      PARAMETER  (PI = 3.141593, N_max = 200000)

C================================================================
C     Explicit Type Declarations for all Variables and Arrays
=================================================================

      INTEGER*4       I_CYCLE, LUCIN, LUCOUT, N, NUMBER_OF_CYCLES

      REAL*4          DX, X1, VERSION_NUMBER, Y(N_max)
      REAL*4          KK,GG,SS,SQM,KOM,FM,BASE,URAT,BDES
      REAL*4          KTEN,KEXP,SHZ,DHZ,DBS,FF,RMS, SQS
      REAL*4          out_X(25), out_Y(25)
      INTEGER*2       IBN,K,INT,K1,K2,IERR,NPT,ICH
C
      CHARACTER*16    DATA_X, DATA_Y, UNITS_X, UNITS_Y
      CHARACTER*32    PROGRAM
      CHARACTER       PROGRAM_NAME*12
```

```
C=====================================================================
      Initialize GEDAP System
 =====================================================================
C
      PROGRAM_NAME    = 'ISO'
      VERSION_NUMBER  = 1.0
      CALL OPEN_GEDAP_NOLIST ( PROGRAM_NAME, VERSION_NUMBER,
     +                         LUCIN, LUCOUT )

 ---------------------------------------------------------------------
C     Obtain the Number of Program Cycles
 ---------------------------------------------------------------------

      NUMBER_OF_CYCLES = 1
      CALL PAR_INTEGER_DEFAULT ( 'number of program cycles [1]',
     +                           NUMBER_OF_CYCLES )
C
C=====================================================================
      Open GEDAP Input and Output File Streams
 =====================================================================
C
      CALL OPEN_INPUT_STREAM  ( 1, 'name of input file' )
      CALL OPEN_OUTPUT_STREAM ( 1, 'name of output file' )
C
C=====================================================================
   Read Conversational Input Parameters using subroutines PAR_REAL,
   PAR_INTEGER, PAR_CHAR, etc.
C=====================================================================


C*********************************************************************
C***  S T A R T   O F   M A I N   R E C Y C L I N G   L O O P  *******
**********************************************************************

      I_CYCLE = 1
      DO WHILE ( I_CYCLE .LE. NUMBER_OF_CYCLES )

C=====================================================================
C        Read data from a GEDAP type V1 input file into array Y
 =====================================================================
C
         CALL READ_GEDAP_V1 ( 1, N_max, N, DX, X1, Y,
     +                        DATA_X, UNITS_X, DATA_Y, UNITS_Y )

C=====================================================================
C **********    U S E R   C O D E   S T A R T S   H E R E   **********
 =====================================================================
C
      NPPCH = N
      HZPCH = DX
      NFRQ = NPPCH               ! number of frequency components
      FUND = DX                  ! fundamental (resolution) of spectrum
      do k = 1, NFRQ             ! harmonic frequencies in FFT spectrum
        FREQ(k) = k * FUND       ! Fundamental to Nyquist (no DC term)
      end do

      NBAN = 25                  ! in case filters are already made
      BDES  = 1. / 3.            ! bandwidth designator (1/3 octave)
      URAT  = 2.0 ** BDES        ! frequency ratio, binary base
      do IBN = 1,NBAN            ! generate needed arrays
        KTEN = IBN / 10          ! which decade is this band
        BASE = 10. ** KTEN       ! DEC-->BASE:  0:1  1=10   2=100  3=1000
        KEXP = IBN - 10*KTEN - 1
```

```
        FM = BASE *( URAT**KEXP ) ! calculate exact mid-band frequency
        FMID(IBN) = FM            ! store it in table
        kom = FM / FUND + 0.5    ! component nearest FMID in spectrum
        LMID(IBN) = kom          ! save its location
      end do
C
      call MAKE_FILTERS                    ! FILTER.OCT made & closed
C
      do K = 1, NFRQ                       ! compute (once) squared fft
         SIGSQ(K) = 2 * DX * Y(K)          ! squared mag of signal
      end do
C
      do IBN = 1, NBAN                     ! all 25 band filters
         SQS = 0                           ! initialize sum of SQUARES
         call FILTER_GAIN(IBN,FMID(IBN),LMID(IBN),K1,K2)
         do kk = K1,K2                     ! sum terms above threshold
            GG = GAINSQ(kk)                ! pre-computed squared filter gain
            SS = SIGSQ (kk)                ! pre-computed squared signal
            FF = GG * SS                   ! filter the signal
            SQS = SQS + FF                 ! add filtered term
            enddo                          ! next component
C
         SQM = SQS / 2.                    ! MEAN of SQUARES
         RMS = sqrt(SQM)                   ! ROOT-MEAN-SQUARES

         if ( RMS.gt. 1.e-12 ) then
            DBS = 20 * alog10( RMS )       ! convert to deciBels
          else
            DBS = -999.                    ! if zero signal
         endif
C
         out_X(IBN) = FMID(IBN)
         out_Y(IBN) = RMS
      enddo                                ! all bands done
C
C=====================================================================
C  Store parameters in B-Header using subroutines PUT_REAL_PARAMETER,
C  PUT_INTEGER_PARAMETER and PUT_CHARACTER_PARAMETER.    (Optional)
C=====================================================================
C
C
C=====================================================================
C       Write data from array Y into a GEDAP type V1 output file
C=====================================================================
C
        CALL WRITE_GEDAP_V2 ( 1, 25, out_X, out_Y,
     +                        DATA_X, UNITS_X, DATA_Y, UNITS_Y )
C
C*********************************************************************
C***   E N D   O F   M A I N   R E C Y C L I N G   L O O P   ***********
C*********************************************************************
C
        I_CYCLE = I_CYCLE + 1
      END DO
C
C=====================================================================
C     Close GEDAP and Terminate Program
C=====================================================================
C
      CALL CLOSE_GEDAP (0)
      CALL EXIT
      END
```

```
subroutine        MAKE_FILTERS

include           'COMMONS.OCT'

BDES  = 1. / 3.                     ! bandwidth designator (1/3 octave)
URAT  = 2.0 ** BDES                 ! frequency ratio, binary base

! band number,    KB =     (1) ... (10)    (11) ... (20)    (21) ... (25)
! midband Hz,    FM =      1.0 ...  8.0    10.0 ... 80.0     100 ...  250 Hz

do IBN = 1, NBAN                    ! store gains of 25 band filters on disk

   KTEN = IBN / 10                  ! which decade is this band
   BASE = 10. ** KTEN               ! DEC-->BASE:  0:1  1=10   2=100  3=1000
   KEXP = IBN - 10*KTEN - 1
   FM = BASE *( URAT**KEXP )        ! calculate exact mid-band frequency
   FMID( IBN ) = FM                 ! store it in table
   kom = FM / FUND + 0.5            ! component nearest FMID in spectrum
   LMID( IBN ) = kom                ! save its location
   call FILTER_GAIN( IBN, FM, kom, K1,K2 )        ! compute filter gain

enddo

RETURN
END
```

Program SPECF.FOR

```
C     SPECF.FOR  -  This program calculates the crest factor of a spectral
C                   distribution. This a form2 program.
C
C                -  It also types the resulting waveform as to whether it is
C                   a type 1 - Guassian, type 2 - Tonal or
C                   type 3a - nonstationary changing mean level or
C                   type 3b - nonstationary shock.
C
C                -  The program also calculates normalized (to 60 sec.)
C                   dose quantities.
C
C                -  FORM2 does not include cycling.
C
C                -  Use FORM2A for type V2 data files with cycling.
C
C                -  Use FORM1 or FORM1A for V1 data files.
C------------------------------------------------------------------------

      PROGRAM SPECF

C------------------------------------------------------------------------
C     Program Description
C------------------------------------------------------------------------
C     This program calculates the crest factor for a spectral distribution
C     defined for a type V2 data file. This type of file is created by prog.
C     ISO.FOR which calculates the third-octave spectrum from the spectral
C     density file create by GEDAP program VSD.
C
C     The program also types the signal according to the values of the parameters, RMT/RMS,
C and the value
C     of the spectrum crest factor, specf.
C
C------------------------------------------------------------------------
C     Definition of GEDAP Data Files
C------------------------------------------------------------------------
C     To link this code to GEDAP type @specf.lnk
C
C------------------------------------------------------------------------
C     Development History
C------------------------------------------------------------------------
C
C     Version 1.0 by George Roddan (BCR)                        21-SEPT-92
C
C***********************************************************************
C
C=======================================================================
C     Parameter Statements for User Constants and Array Dimensions
C=======================================================================
C
      IMPLICIT    NONE
C
      LOGICAL     PAF
      INTEGER*4   N_max
      REAL*4      PI
      PARAMETER  (PI = 3.141593, N_max = 250000)
C
C=======================================================================
C     Explicit Type Declarations for all Variables and Arrays
C=======================================================================
C
      INTEGER*4     LUCIN, LUCOUT, N, COUNT, L1, L2, L3
```

```
C
      REAL*4          VERSION_NUMBER, X(N_max), Y(N_max), SPEC_CF
      REAL*4          MAX_VALUE, MEAN_VALUE, I_97, RMT_RMS, TS, SUM
      REAL*4          VRV,VDV,VTTV,VRV60,VDV60,VTTV60,SPEED
      REAL*4          SIGNAL_TYPE
C
      CHARACTER*16    DATA_X, DATA_Y, UNITS_X, UNITS_Y
      CHARACTER*16    RUN_FILE, RUN_FILE1, ROAD_TYPE, DIR_ECTION
      CHARACTER*32    PROGRAM_NAME
      CHARACTER*80    CORE_NAME, FILE_TYPE, PAF_FILE, DIRECTORY
      CHARACTER*80    FILE_NAME
C
C=====================================================================
C     Initialize GEDAP System
C=====================================================================
C
      PROGRAM_NAME    = 'SPECF'
      VERSION_NUMBER  = 1.0
      CALL OPEN_GEDAP_NOLIST ( PROGRAM_NAME, VERSION_NUMBER,
     +                         LUCIN, LUCOUT )

C
C=====================================================================
C     Open GEDAP Input and Output File Streams
C=====================================================================
C
      CALL OPEN_INPUT_STREAM  ( 1, 'name of input file' )

C=====================================================================
C     Read data from a GEDAP type V2 input file into array Y
C=====================================================================
C
      CALL READ_GEDAP_V2 ( 1, N_max, N, X, Y,
     +                     DATA_X, UNITS_X, DATA_Y, UNITS_Y )
C
C Input appropriate GEDAP Header Parameters.

      CALL FETCH_REAL_PARAMETER ( 'I_97', I_97 )


C=====================================================================
C     Open GEDAP Input and Output File Streams
C=====================================================================
C
      CALL OPEN_INPUT_STREAM  ( 2, 'name of input file' )
      CALL OPEN_OUTPUT_STREAM ( 2, 'name of output file' )
C
C=====================================================================
C  Read Conversational Input Parameters using subroutines PAR_REAL,
C  PAR_INTEGER, PAR_CHAR, etc.
C=====================================================================
C
      CALL PAR_CHAR ('input run-file', RUN_FILE1)
      CALL PAR_REAL ('input speed', SPEED )
      CALL PAR_CHAR ('input road type', ROAD_TYPE)
      CALL PAR_CHAR ('input axis direction', DIR_ECTION)
      CALL PARSE_FILE_SPEC (RUN_FILE1, RUN_FILE,
     +L1, FILE_TYPE, L2 )
C
C=====================================================================
C     Read data from a GEDAP type V2 input file into array Y
C=====================================================================
C
```

```
      CALL READ_GEDAP_V2 ( 2, N_max, N, X, Y,
     +                     DATA_X, UNITS_X, DATA_Y, UNITS_Y )
      CALL GET_INPUT_FILE (2, FILE_NAME)
      CALL PARSE_FILE_SPEC (FILE_NAME, CORE_NAME, L1,
     +FILE_TYPE, L2)
C
C Input appropriate GEDAP Header Parameters.

      CALL FETCH_REAL_PARAMETER ( 'OB_RMTT_RMS', RMT_RMS )
      CALL FETCH_REAL_PARAMETER ( 'VRV', VRV )
      CALL FETCH_REAL_PARAMETER ( 'VDV', VDV )
      CALL FETCH_REAL_PARAMETER ( 'VTTV', VTTV )
      CALL FETCH_REAL_PARAMETER ( 'Ts',  TS )
C=====================================================================
C **********   U S E R   C O D E   S T A R T S   H E R E   **********
C=====================================================================
C
C     First determine mean value

      SUM = 0.0
      DO COUNT = 1,N
         SUM = SUM + Y(COUNT)
      END DO
      MEAN_VALUE = SUM/N
C
C
C     Determine maximum value

      MAX_VALUE = Y(1)
      DO COUNT = 2,N
         IF (Y(COUNT).GT.MAX_VALUE) THEN
         MAX_VALUE = Y(COUNT)
         ENDIF
      END DO
C
C     Calculate SPECF, spectral Crest Factor

      SPEC_CF = MAX_VALUE/MEAN_VALUE
C
C=====================================================================
C Start of code to type signal
C=====================================================================

C  Type 1 - Gaussian Signal

       IF (((RMT_RMS.GT.2.0).AND.(RMT_RMS.LT.2.5))
     +.AND.((I_97.LT.2.3).AND.(SPEC_CF.LT.4.0))) THEN
       SIGNAL_TYPE = 1
       ENDIF
C
C  Type 2 - Tonal Signal

       IF ((RMT_RMS.LT.2.0).OR.(((RMT_RMS.GT.2.0).AND.
     +(RMT_RMS.LT.2.5)).AND.(SPEC_CF.GE.4.0))) THEN
       SIGNAL_TYPE = 2
       ENDIF
C
C  Type 3 - Non-stationary Signal - of varying mean level

       IF ((((RMT_RMS.GT.2.0).AND.(RMT_RMS.LT.2.5)).AND.
     +(I_97.GE.2.3)).OR.((RMT_RMS.GE.2.5).AND.(I_97.GT.2.6)))
```

```
     THEN
      SIGNAL_TYPE = 3
      ENDIF
C
C Type 4 - Non-stationary Signal - containing shocks

      IF ((RMT_RMS.GE.2.5).AND.(I_97.LE.2.6)) THEN
      SIGNAL_TYPE = 4
      ENDIF
C
C=========================================================================
C Start of code to calculate normalized 60 second dose
C See PP. 14  British Standard 6841  Appendix A.3
C
C=========================================================================
C
     IF (VRV.LT.0.001) THEN
        VRV60=0.00
        VDV60=0.00
        VTTV60=0.00
        GOTO 999
     ENDIF

C 60 sec. dose based on rms (2)

     VRV60 = ((60/TS)* VRV**2)**.5
C
C 60 sec. dose based on rmq (4)

     VDV60 = ((60/TS)* VDV**4)**.25
C
C 60 sec. dose based on rmt (12)

     VTTV60 = ((60/TS)* VTTV**(12.))**(1./12.)


C
C=========================================================================
C Store parameters in B-Header using subroutines PUT_REAL_PARAMETER,
C PUT_INTEGER_PARAMETER and PUT_CHARACTER_PARAMETER.    (Optional)
C=========================================================================
C

999    CALL PUT_REAL_PARAMETER('SPECF',SPEC_CF)
       CALL PUT_REAL_PARAMETER('VRV60',VRV60)
       CALL PUT_REAL_PARAMETER('VDV60',VDV60)
       CALL PUT_REAL_PARAMETER('VTTV60',VTTV60)
       CALL PUT_REAL_PARAMETER('TS',TS)
       CALL PUT_REAL_PARAMETER('SPEED', SPEED)
       CALL PUT_REAL_PARAMETER('SIGNAL_TYPE', SIGNAL_TYPE)

       CALL PUT_CHARACTER_PARAMETER('RUN_FILE', RUN_FILE)
       CALL PUT_CHARACTER_PARAMETER('ROAD_TYPE', ROAD_TYPE)
       CALL PUT_CHARACTER_PARAMETER('DIR_ECTION', DIR_ECTION)

C=========================================================================
C Add new parameters to the Parameter Accumulation File
C=========================================================================

     CALL OPEN_ACCUMULATE ( FILE_TYPE(1:L2) , PAF, PAF_FILE)
     IF (PAF) THEN
      CALL PUT_REAL_PARAMETER('SPECF',SPEC_CF)
```

```
         CALL PUT_REAL_PARAMETER('VRV60',VRV60)
         CALL PUT_REAL_PARAMETER('VDV60',VDV60)
         CALL PUT_REAL_PARAMETER('VTTV60',VTTV60)
         CALL PUT_REAL_PARAMETER('TS',TS)
         CALL PUT_REAL_PARAMETER('SPEED', SPEED)
         CALL PUT_REAL_PARAMETER('SIGNAL_TYPE', SIGNAL_TYPE)

         CALL PUT_CHARACTER_PARAMETER('RUN_FILE', RUN_FILE)
         CALL PUT_CHARACTER_PARAMETER('ROAD_TYPE', ROAD_TYPE)
         CALL PUT_CHARACTER_PARAMETER('DIR_ECTION', DIR_ECTION)

         CALL CLOSE_ACCUMULATE (PAF_FILE)
        ENDIF
C=======================================================================
C     Write data from array Y into a GEDAP type V2 output file
C=======================================================================
C
      CALL WRITE_GEDAP_V2 ( 2, N, X, Y,
     +                      DATA_X, UNITS_X, DATA_Y, UNITS_Y )
C
C=======================================================================
C     Close GEDAP and Terminate Program
C=======================================================================
C
      CALL CLOSE_GEDAP (0)
      CALL EXIT
      END
```

Program APPEND.FOR

```
C-----------------------------------------------------------------------
C  APPEND.FOR  -  This program joins two Gedap V1 files together
C                 and outputs a single file.
C
C-----------------------------------------------------------------------
C
       PROGRAM APPEND
C
C-----------------------------------------------------------------------
C  Program Description
C-----------------------------------------------------------------------
C  This program joins two GEDAP V1 files together. The program assumes
C  that they have the same units.
C
C-----------------------------------------------------------------------
C  Definition of GEDAP Data Files
C-----------------------------------------------------------------------
C  To link this code to GEDAP type @append.lnk
C
C-----------------------------------------------------------------------
C  Development History
C-----------------------------------------------------------------------
C
C  Version 1.0 by Brian Remedios (BCR)                          28-OCT-92
C
C***********************************************************************
C
C=======================================================================
C    Parameter Statements for User Constants and Array Dimensions
C=======================================================================
C
      IMPLICIT    NONE
C
      LOGICAL     PAF
      INTEGER*4   N_max
      REAL*4      PI
      PARAMETER  (PI = 3.141593, N_max = 262144)
C
C=======================================================================
C    Explicit Type Declarations for all Variables and Arrays
C=======================================================================
C
      INTEGER*4     LUCIN, LUCOUT, N1, N2, COUNT, L1, L2, L3
      INTEGER*4     ISTATUS
C

      REAL*4        VERSION_NUMBER, X1, Y1(N_max)
      REAL*4        X2, Y2(N_max), Y3(N_max), DX, DX2

C
      CHARACTER*16  DATA_X, DATA_Y, UNITS_X, UNITS_Y
      CHARACTER*16  DATA_X2, DATA_Y2, UNITS_X2, UNITS_Y2
      CHARACTER*16  RUN_FILE, RUN_FILE1, ROAD_TYPE, DIR_ECTION
      CHARACTER*32  PROGRAM_NAME
      CHARACTER*80  CORE_NAME, FILE_TYPE, PAF_FILE, DIRECTORY
      CHARACTER*80  FILE_NAME
C
C=======================================================================
C    Initialize GEDAP System
C=======================================================================
C
      PROGRAM_NAME    = 'APPEND'
```

```
      VERSION_NUMBER  = 1.0
      CALL OPEN_GEDAP_NOLIST ( PROGRAM_NAME, VERSION_NUMBER,
     +                         LUCIN, LUCOUT )

C
C=====================================================================
C     Open GEDAP Input and Output File Streams
C=====================================================================
C

      CALL OPEN_INPUT_FILE_STREAM ( 1, 'name of first input file',
     + ISTATUS)

      CALL OPEN_INPUT_FILE_STREAM ( 2, 'name of second input file',
     + ISTATUS)

C=====================================================================
C     Read data from a GEDAP type V1 input files into arrays Y1, and Y2
C=====================================================================
C

      CALL READ_GEDAP_V1 ( 1, N_max, N1, DX , X1, Y1,
     +                     DATA_X, UNITS_X, DATA_Y, UNITS_Y )

      CALL READ_GEDAP_V1 ( 2, N_max, N2, DX2 , X2, Y2,
     +                     DATA_X2, UNITS_X2, DATA_Y2, UNITS_Y2 )

C=====================================================================
C     Open GEDAP Input and Output File Streams
C=====================================================================

      CALL OPEN_OUTPUT_FILE_STREAM ( 3, 'name of output file',
     + ISTATUS )

C=====================================================================
C Read Conversational Input Parameters using subroutines PAR_REAL,
C PAR_INTEGER, PAR_CHAR, etc.
C=====================================================================
C
C=====================================================================
C **********    U S E R   C O D E   S T A R T S   H E R E    **********
C=====================================================================
C
C     Join the two arrays together into a third array


      DO COUNT = 1,N1
         Y3(count) = Y1(count)
      END DO

      DO COUNT = 1,N2
        Y3(count+N1) = Y2(count)
      END DO

C=====================================================================
C     Write data from array Y into a GEDAP type V1 output file
C=====================================================================

      CALL WRITE_GEDAP_1 ( 3, DX, X1, N1+N2, Y3, DATA_X, UNITS_X,
     +     DATA_Y, UNITS_Y, PROGRAM_NAME, VERSION_NUMBER,ISTATUS)

C=====================================================================
C     Close GEDAP and Terminate Program
C=====================================================================
```

```
C
      CALL CLOSE_GEDAP (0)
      CALL EXIT
      END
```

Program MULTIXY.FOR

```
C    MULTIXY.FOR  -  This program multiplies a Gedap V1 file with a user
C                    specified "shape" function point for point and
                     outputs a single file.
                  -  This program was developed for creating signal
C                    control files with varying rms levels in the
                     USAARL project.
C------------------------------------------------------------------------
C
      PROGRAM MULTIXY

C------------------------------------------------------------------------
C    Program Description
C------------------------------------------------------------------------
C    This program multiplys a GEDAP V1 file together with a user specified
C    "shape" function.
C
C------------------------------------------------------------------------
C    Definition of GEDAP Data Files
C------------------------------------------------------------------------
C    To link this code to GEDAP type @multixy.lnk
C
C------------------------------------------------------------------------
C    Development History
C------------------------------------------------------------------------
C
C    Version 1.0 by George Roddan (BCR)                         18-OCT-92
C************************************************************************
C
C========================================================================
C      Parameter Statements for User Constants and Array Dimensions
C========================================================================
C
      IMPLICIT    NONE
C
      LOGICAL     PAF
      INTEGER*4   N_max
      REAL*4      PI
      PARAMETER  (PI = 3.141593, N_max = 262144)
C
C========================================================================
C     Explicit Type Declarations for all Variables and Arrays
C========================================================================

      INTEGER*4     LUCIN, LUCOUT, N, N2, COUNT, L1, L2, L3
      INTEGER*4     ISTATUS, Nz,  Nramp

      REAL*4        VERSION_NUMBER, X1, Y1(N_max)
      REAL*4        X2, Y2(N_max), DX, DX2, L11, L22


      CHARACTER*16  DATA_X, DATA_Y, UNITS_X, UNITS_Y
      CHARACTER*16  DATA_X2, DATA_Y2, UNITS_X2, UNITS_Y2
      CHARACTER*16  RUN_FILE, RUN_FILE1, ROAD_TYPE, DIR_ECTION
      CHARACTER*32  PROGRAM_NAME
      CHARACTER*80  CORE_NAME, FILE_TYPE, PAF_FILE, DIRECTORY
      CHARACTER*80  FILE_NAME
C
C========================================================================
C     Initialize GEDAP System
C========================================================================
```

```
C
      PROGRAM_NAME    = 'MULTIXY'
      VERSION_NUMBER  = 1.0
      CALL OPEN_GEDAP_NOLIST ( PROGRAM_NAME, VERSION_NUMBER,
     +                         LUCIN, LUCOUT )

C
C=======================================================================
      Open GEDAP Input and Output File Streams
 =======================================================================
C
      CALL OPEN_INPUT_FILE_STREAM ( 1, 'name of input file',
     + ISTATUS)

C=======================================================================
      Read data from a GEDAP type V1 input file into array Y1
 =======================================================================
C
      CALL READ_GEDAP_V1 ( 1, N_max, N, DX , X1, Y1,
     +                     DATA_X, UNITS_X, DATA_Y, UNITS_Y )

C
 =======================================================================
C     Open GEDAP Input and Output File Streams
C=======================================================================

      CALL OPEN_OUTPUT_FILE_STREAM ( 2, 'name of output file',
     + ISTATUS )
C
 =======================================================================
C  Read Conversational Input Parameters using subroutines PAR_REAL,
C  PAR_INTEGER, PAR_CHAR, etc.
 =======================================================================

       CALL PAR_INTEGER ('input (index) loc. of level change', Nz)
       CALL PAR_INTEGER ('input (index) ramp length', Nramp)
       CALL PAR_REAL ('input first level multiplier', L11)
       CALL PAR_REAL ('input second level multiplier', L22)

C=======================================================================
C **********   U S E R   C O D E   S T A R T S   H E R E   **********
 =======================================================================

C     Create 'shape' array

      DO COUNT = 1, Nz - Nramp/2
         Y2(count) = L11
      END DO

      DO COUNT = Nz + Nramp/2, N
         Y2(count) = L22
      END DO

C     ramp part of array

      DO COUNT = 1, Nramp
         Y2(NZ - Nramp/2 + count)=
     +          (Float(count)/Float(Nramp))*(L22 - L11) + L11
      END DO

C     Multiply the two arrays together
```

```
      DO COUNT = 1,N
         Y2(count) = Y1(COUNT)*Y2(COUNT)
      END DO

C=====================================================================
C     Write data from array Y into a GEDAP type V1 output file
C=====================================================================
C
      CALL WRITE_GEDAP_1 ( 2, DX, X1, N, Y2, DATA_X, UNITS_X,
     +     DATA_Y, UNITS_Y, PROGRAM_NAME, VERSION_NUMBER,ISTATUS)

C=====================================================================
C     Close GEDAP and Terminate Program
C=====================================================================
C
      CALL CLOSE_GEDAP (0)
      CALL EXIT
      END
```

Program SHOCK.FOR

```
C   SHOCK.FOR  -  This program generates a shock file whichs
C                 contains a patern of user specified shocks


C
C----------------------------------------------------------------------

        PROGRAM SHOCK
C
 ----------------------------------------------------------------------
    Program Description
C----------------------------------------------------------------------


C
C----------------------------------------------------------------------
    Definition of GEDAP Data Files
 ----------------------------------------------------------------------
C   To link this code to GEDAP type @shock.lnk

 ----------------------------------------------------------------------
C   Development History
C----------------------------------------------------------------------

C   Version 1.0 by George Roddan (BCR)                         14-OCT-92
C
 ***********************************************************************

C======================================================================
C     Parameter Statements for User Constants and Array Dimensions
 ======================================================================
C
      IMPLICIT    NONE

      LOGICAL     PAF
      INTEGER*4   N_max
      REAL*4      PI
      PARAMETER  (PI = 3.141593, N_max = 262144)
C
C======================================================================
C     Explicit Type Declarations for all Variables and Arrays
C======================================================================
C
      INTEGER*4       LUCIN, LUCOUT, N, N2, COUNT, L1, L2, L3
      INTEGER*4       ISTATUS, loc, K
C

      REAL*4          VERSION_NUMBER, X1, sh(500)
      REAL*4          X2, Y(N_max), DX, freq, peak


      CHARACTER*16    DATA_X, DATA_Y, UNITS_X, UNITS_Y
      CHARACTER*16    DATA_X2, DATA_Y2, UNITS_X2, UNITS_Y2
      CHARACTER*16    RUN_FILE, RUN_FILE1, ROAD_TYPE, DIR_ECTION
      CHARACTER*32    PROGRAM_NAME
      CHARACTER*80    CORE_NAME, FILE_TYPE, PAF_FILE, DIRECTORY
      CHARACTER*80    FILE_NAME
C
C======================================================================
C     Initialize GEDAP System
C======================================================================
```

```
C
      PROGRAM_NAME     = 'SHOCK'
      VERSION_NUMBER   = 1.0
      CALL OPEN_GEDAP_NOLIST ( PROGRAM_NAME, VERSION_NUMBER,
     +                         LUCIN, LUCOUT )
C
C=====================================================================
C     Open GEDAP Input and Output File Streams
C=====================================================================
C
C=====================================================================
C     Open GEDAP Input and Output File Streams
C=====================================================================
C
      CALL OPEN_OUTPUT_FILE_STREAM ( 3, 'name of output file',
     + ISTATUS )
C
C=====================================================================
C  Read Conversational Input Parameters using subroutines PAR_REAL,
C  PAR_INTEGER, PAR_CHAR, etc.
C=====================================================================

      CALL PAR_INTEGER ('Enter length of record ', N )
      CAll PAR_INTEGER ('Enter no. of shocks', N2)

C=====================================================================
C **********   U S E R   C O D E   S T A R T S   H E R E   **********
C=====================================================================
C
C     Initialize array

      DO COUNT = 1,N
         Y(count) = 0.0
      END DO

C     Set time spacing at .01 seconds

      DX = .01

C     insert shocks at appropriate locations

      DO count = 1, N2

         CALL PAR_INTEGER ('Input shock location (index)', loc )
         CALL PAR_REAL ('Input shock freq. (hz)', freq )
         CALL PAR_REAL ('Input shock peak (m/sec^2)', peak)

        DO k = 1,500

           sh(k) = peak*1.73*sin(PI*(k-1)*freq/50.)*exp(-2.5*(
     +             k-1)*freq/100.)
        ENDDO

        DO k = 1,500

           if(loc+k.GE.N) go to 90
           y(loc + k) = sh(k)

        ENDDO
      ENDDO
C=====================================================================
```

```
C     Write data from array Y into a GEDAP type V1 output file
C=====================================================================
C
90    CALL WRITE_GEDAP_1 ( 3, DX, X1, N, Y, DATA_X, UNITS_X,
     +     DATA_Y, UNITS_Y, PROGRAM_NAME, VERSION_NUMBER,ISTATUS)

C=====================================================================
C     Close GEDAP and Terminate Program
C=====================================================================
C
      CALL CLOSE_GEDAP (0)
      CALL EXIT
      END
```

Program SNIP_GAUSSIAN.FOR

```
C----------------------------------------------------------------
C    SNIP_GAUSSIAN.FOR - This program multiplies a Gedap V1 file with a user
C                        specified "shape" function point for point and
C                        outputs a single file.
C
C                      - This program was developed for creating signal
C                        control files with varying rms levels in the
C                        USAARL project.
C
C----------------------------------------------------------------
C
        PROGRAM SNIP_GAUSSIAN
C
C----------------------------------------------------------------
C    Program Description
C----------------------------------------------------------------
C    This program multiplys a GEDAP V1 file together ( usually the Gaussian
C    backround file with) a user specified "shape" function. This "shape"
C    function is defined using input from a command file similar to the one
C    used to generate the shock profiles, which are usually of the form,
C    sh*_gencom.
C
C    Information on the location and frequency of each generated shock will
C    then be used to "snip" out the appropriate portion of the Guassian so
C    that the shock can then be inserted without affecting its absolute
C    peak value.
C
C    This program would normally be run before the shock and Gaussiann files
C    are combined using GEDAP program ADDXY.for.
C----------------------------------------------------------------
C    Definition of GEDAP Data Files
C----------------------------------------------------------------
C    To compile and link this code to GEDAP type @SNIP_GAUSSIAN.lnk
C    This is a command file which contains: $LINK SNIP_GAUSSIAN,G2$:GEDAP/LIB
C----------------------------------------------------------------
C    Development History
C----------------------------------------------------------------
C
C    Version 1.0 by George Roddan (BCR)                      08-DEC-92
C
C********************************************************************
C
C=====================================================================
C      Parameter Statements for User Constants and Array Dimensions
C=====================================================================
C
        IMPLICIT      NONE
C
        LOGICAL       PAF
        INTEGER*4     N_max
        REAL*4        PI
        PARAMETER  (PI = 3.141593, N_max = 600000)
C
C=====================================================================
C      Explicit Type Declarations for all Variables and Arrays
C=====================================================================

        INTEGER*4     LUCIN, LUCOUT, N, N2, COUNT
        INTEGER*4     ISTATUS, loc(1000), N_LENGTH, N_SHOCKS

        REAL*4        VERSION_NUMBER, X1, Y1(N_max),K , freq(1000)
        REAL*4        X2, Y2(N_max), DX, DX2, L11(100), peak(1000)
```

```
      CHARACTER*16  DATA_X, DATA_Y, UNITS_X, UNITS_Y
      CHARACTER*16  DATA_X2, DATA_Y2, UNITS_X2, UNITS_Y2
      CHARACTER*16  RUN_FILE, RUN_FILE1, ROAD_TYPE, DIR_ECTION
      CHARACTER*32  PROGRAM_NAME
      CHARACTER*80  CORE_NAME, FILE_TYPE, PAF_FILE, DIRECTORY
      CHARACTER*80  FILE_NAME

C=====================================================================
C     Initialize GEDAP System
C=====================================================================
C
      PROGRAM_NAME= 'MULTIXY'
      VERSION_NUMBER  = 1.0
      CALL OPEN_GEDAP_NOLIST ( PROGRAM_NAME, VERSION_NUMBER,
     +                         LUCIN, LUCOUT )


C=====================================================================
C     Open GEDAP Input and Output File Streams
C=====================================================================
C

      CALL OPEN_INPUT_FILE_STREAM ( 1, 'name of input Gaussian
     +                              file', ISTATUS)

C=====================================================================
C     Read data from a GEDAP type V1 input file into array Y1
C=====================================================================
C
      CALL READ_GEDAP_V1 ( 1, N_max, N, DX , X1, Y1,
     +                     DATA_X, UNITS_X, DATA_Y, UNITS_Y )


C=====================================================================
C     Open GEDAP Input and Output File Streams
C=====================================================================

      CALL OPEN_OUTPUT_FILE_STREAM ( 2, 'name of output Gaussian
     +                               file',ISTATUS )

C=====================================================================
C Read Conversational Input Parameters using subroutines PAR_REAL,
C PAR_INTEGER, PAR_CHAR, etc.
C=====================================================================

       CALL PAR_INTEGER ('Enter length of record ',N_length )
       CALL PAR_INTEGER ('Enter no. of shocks', N_shocks)

       DO K = 1 , N_shocks

       CALL PAR_INTEGER ('input shock location (index)', loc(k))
       CALL PAR_REAL ('input shock freq. (hz)', freq(k))
       CALL PAR_REAL ('input shock peak (m/sec^2)', peak(k))

       END DO
C
C=====================================================================
C**********     USER   CODE   STARTS   HERE     **********
C=====================================================================
```

```
:       Createc 'shape' array

        DX= .01

:       First get initialize "shape" array equal to one at each point

        DO K = 1, N_length

                Y2(k) = 1.0        ! shape array

        END DO

C       Next put equal to 0.0 the appropriate locations in the shape array.
C       When the input Gaussian is multiplied by this array the portions
:       of the signal where the shocks will be inserted (using GEDAP program
C       ADDXY) will be effectively "snipped" out.

        DO K= 1 , N_shocks          ! shock counter

        N2 = INT(1.0 / (freq(k)*DX))

           DO COUNT = 1, N2     ! "snipper"

                Y2(loc(k + count - 1)= 0.0

           END DO

        END DO

C       Multiply the two arrays together

        DO COUNT = 1,N

             Y2(count) = Y1(COUNT)*Y2(COUNT)

        END DO

:==================================================================
:       Write data from array Y into a GEDAP type V1 output file
C==================================================================
C
        CALL WRITE_GEDAP_1 ( 2, DX, X1, N, Y2, DATA_X, UNITS_X,
      +       DATA_Y, UNITS_Y, PROGRAM_NAME, VERSION_NUMBER,ISTATUS)

:==================================================================
C       Close GEDAP and Terminate Program
C==================================================================

        CALL CLOSE_GEDAP (0)
        CALL EXIT
        END
```

Program ADDXY.FOR

```
C-----------------------------------------------------------------------
C  ADDXY.FOR  -  This program adds two Gedap V1 files together
C                and outputs a single file
C
C
C
C
C-----------------------------------------------------------------------
C
C
      PROGRAM ADDXY
C
C-----------------------------------------------------------------------
C  Program Description
C-----------------------------------------------------------------------
C  This program adds two GEDAP V1 files together. The program assumes a
C  number of things about the input files. They must have the same units
C  no. of points and time spacing.
C-----------------------------------------------------------------------
C  Definition of GEDAP Data Files
C-----------------------------------------------------------------------
C  To link this code to GEDAP type @addxy.lnk
C
C-----------------------------------------------------------------------
C  Development History
C-----------------------------------------------------------------------
C
C  Version 1.0 by George Roddan (BCR)                        13-OCT-92
C
C***********************************************************************
C
C
C=======================================================================
C     Parameter Statements for User Constants and Array Dimensions
C=======================================================================
C
      IMPLICIT    NONE
C
      LOGICAL     PAF
      INTEGER*4   N_max
      REAL*4      PI
      PARAMETER  (PI = 3.141593, N_max = 262144)
C
C=======================================================================
C     Explicit Type Declarations for all Variables and Arrays
C=======================================================================
C
      INTEGER*4      LUCIN, LUCOUT, N, N2, COUNT, L1, L2, L3
      INTEGER*4      ISTATUS
C
      REAL*4         VERSION_NUMBER, X1, Y1(N_max)
      REAL*4         X2, Y2(N_max), DX, DX2
C
      CHARACTER*16   DATA_X, DATA_Y, UNITS_X, UNITS_Y
      CHARACTER*16   DATA_X2, DATA_Y2, UNITS_X2, UNITS_Y2
      CHARACTER*16   RUN_FILE, RUN_FILE1, ROAD_TYPE, DIR_ECTION
      CHARACTER*32   PROGRAM_NAME
      CHARACTER*80   CORE_NAME, FILE_TYPE, PAF_FILE, DIRECTORY
      CHARACTER*80   FILE_NAME
C
C=======================================================================
C     Initialize GEDAP System
C=======================================================================
```

```
C
      PROGRAM_NAME    = 'ADDXY'
      VERSION_NUMBER  = 1.0
      CALL OPEN_GEDAP_NOLIST ( PROGRAM_NAME, VERSION_NUMBER,
     +                          LUCIN, LUCOUT )

C
C======================================================================
C     Open GEDAP Input and Output File Streams
C======================================================================
C
      CALL OPEN_INPUT_FILE_STREAM ( 1, 'name of first input file',
     + ISTATUS)

      CALL OPEN_INPUT_FILE_STREAM ( 2, 'name of second input file',
     + ISTATUS)


C======================================================================
C     Read data from a GEDAP type V1 input files into arrays Y1, and Y2
C======================================================================
C
      CALL READ_GEDAP_V1 ( 1, N_max, N, DX , X1, Y1,
     +                     DATA_X, UNITS_X, DATA_Y, UNITS_Y )

      CALL READ_GEDAP_V1 ( 2, N_max, N2, DX2 , X2, Y2,
     +                     DATA_X2, UNITS_X2, DATA_Y2, UNITS_Y2 )
C
C======================================================================
C     Open GEDAP Input and Output File Streams
C======================================================================
C
      CALL OPEN_OUTPUT_FILE_STREAM ( 3, 'name of output file',
     + ISTATUS )
C
C======================================================================
C Read Conversational Input Parameters using subroutines PAR_REAL,
C PAR_INTEGER, PAR_CHAR, etc.
C======================================================================
C
C
C======================================================================
C **********    U S E R   C O D E   S T A R T S   H E R E    **********
C======================================================================
C
C     Add two arrays together

      DO COUNT = 1,N
         Y2(count) = Y1(COUNT) + Y2(COUNT)
      END DO

C======================================================================
C     Write data from array Y into a GEDAP type V1 output file
C======================================================================
C
      CALL WRITE_GEDAP_1 ( 3, DX, X1, N, Y2, DATA_X, UNITS_X,
     +     DATA_Y, UNITS_Y, PROGRAM_NAME, VERSION_NUMBER,ISTATUS)

C======================================================================
C     Close GEDAP and Terminate Program
C======================================================================
C
      CALL CLOSE_GEDAP (0)
      CALL EXIT
```

Program RAMP.FOR

```
C-----------------------------------------------------------------
C   RAMP.FOR - This program tailors a Gedap V1 file to a slope...
C
C-----------------------------------------------------------------
C
      PROGRAM RAMP
C
C-----------------------------------------------------------------
C   Program Description
C-----------------------------------------------------------------
C   This program generates a GEDAP V1 file. The program assumes
C   that they have the same units as the sacrificial input file.
C
C-----------------------------------------------------------------
C   Definition of GEDAP Data Files
C-----------------------------------------------------------------
C   To link this code to GEDAP type @ramp.lnk
C
C-----------------------------------------------------------------
C   Development History
C-----------------------------------------------------------------
C
C   Version 1.0 by Brian Remedios (BCR)                  28-OCT-92
C
C***********************************************************************
C
C=======================================================================
C     Parameter Statements for User Constants and Array Dimensions
C=======================================================================
C
      IMPLICIT     NONE
C
      LOGICAL      PAF
      INTEGER*4    N_max
      REAL*4       PI
      PARAMETER  (PI = 3.141593, N_max = 262144)
C
C=======================================================================
C     Explicit Type Declarations for all Variables and Arrays
C=======================================================================
C
      INTEGER*4      LUCIN, LUCOUT, COUNT, L1, L2, L3
      INTEGER*4      ISTATUS, SL, LENGTH, N
C
      REAL*4         VERSION_NUMBER, X1, Y1(N_max),SLOPE
      REAL*4         DX, DX2
      REAL*4         START_VAL,STOP_VAL
C
      CHARACTER*16 DATA_X, DATA_Y, UNITS_X, UNITS_Y
      CHARACTER*16 DATA_X2, DATA_Y2, UNITS_X2, UNITS_Y2
      CHARACTER*16 RUN_FILE, RUN_FILE1, ROAD_TYPE, DIR_ECTION
      CHARACTER*32 PROGRAM_NAME
      CHARACTER*80 CORE_NAME, FILE_TYPE, PAF_FILE, DIRECTORY
      CHARACTER*80 FILE_NAME
C
C=======================================================================
C     Initialize GEDAP System
C=======================================================================
C
      PROGRAM_NAME= 'RAMP'
```

```
      VERSION_NUMBER  = 1.0
      CALL OPEN_GEDAP_NOLIST ( PROGRAM_NAME, VERSION_NUMBER,
     +                             LUCIN, LUCOUT )

C
        CALL OPEN_INPUT_FILE_STREAM (1,'Name of input file',
     + ISTATUS)
C=====================================================================
C     Open GEDAP Output File Stream
C=====================================================================
C
C
        CALL READ_GEDAP_V1(1, N_max, N, DX, X1, Y1,
     +              DATA_X, UNITS_X, DATA_Y, UNITS_Y)
C
        CALL PAR_REAL('Enter starting factor',START_VAL)
        CALL PAR_REAL('Enter ending factor',STOP_VAL)
C
        CALL PAR_INTEGER('Enter start of operation',SL)
        CALL PAR_INTEGER('Enter length of data series',LENGTH)
C
C=====================================================================
C     Open GEDAP Input and Output File Streams
C=====================================================================
C
      CALL OPEN_OUTPUT_FILE_STREAM ( 3, 'Name of output file',
     + ISTATUS )
C
C=====================================================================
C Read Conversational Input Parameters using subroutines PAR_REAL,
C PAR_INTEGER, PAR_CHAR, etc.
C=====================================================================
C
C=====================================================================
C **********    U S E R   C O D E   S T A R T S   H E R E   **********
C=====================================================================
C
C     Create the data series...
C
        SLOPE = (STOP_VAL-START_VAL)/LENGTH
C
        DO COUNT=1,LENGTH
          Y1(COUNT+SL) = Y1(COUNT+SL) * (START_VAL+((COUNT-1)*SLOPE))
        END DO
C
C=====================================================================
C     Write data from array Y into a GEDAP type V1 output file
C=====================================================================
C
      CALL WRITE_GEDAP_1 ( 3, DX, X1, N, Y1, DATA_X, UNITS_X,
     +      DATA_Y, UNITS_Y, PROGRAM_NAME, VERSION_NUMBER,ISTATUS)

C=====================================================================
C     Close GEDAP and Terminate Program
C=====================================================================
C
      CALL CLOSE_GEDAP (0)
      CALL EXIT
      END
```

Program TOUSA.COM

```
.$! Reformat three ascii files into a single binary I2 file
$!
$! by BR  Oct 14, 1992
$
$ FORTRAN/NOLIST/OBJECT=TOUSA.OBJ SYS$INPUT

C         Reformat an ascii file into binary
C         - The output fields are all I*2 binary written in fixed length
C         512 byte records.  Records are grouped in threes (ie. rec 1 = X values,
C         rec 2 = Y values, rec 3 = Z values)
C         - The inputs are read as I5 (no zero padding) with new records for
C         each X,Y,Z grouping.

          IMPLICIT NONE
          INTEGER*2 I, J
          INTEGER*2 ARRAY( 3,256)
          INTEGER*4 COUNT_IN /0/, COUNT_OUT /0/
C
C
          OPEN( 5, STATUS='OLD', READONLY)
          OPEN( 7, STATUS='OLD', READONLY)
          OPEN( 8, STATUS='OLD', READONLY)
          OPEN( 6, STATUS='NEW', CARRIAGECONTROL='LIST',
          1         RECORDTYPE='FIXED', RECL=512)

          DO WHILE (.TRUE.)
            DO J = 1, 256
              READ(5,*,END=90) ARRAY( 1,J)
              READ(7,*,END=90) ARRAY( 2,J)
              READ(8,*,END=90) ARRAY( 3,J)
 1000     FORMAT(I5)
              COUNT_IN = COUNT_IN + 1
            END DO

            DO I = 1, 3
              WRITE(6,2000) (ARRAY( I,J), J=1,256)
 2000     FORMAT( 256A2)
              COUNT_OUT = COUNT_OUT + 1
            END DO
          END DO

 90       TYPE *, ' '
          TYPE *, '# of ascii records in:', COUNT_IN
          TYPE *, '# of binary records out:', COUNT_OUT
          TYPE *, ' '
          CALL EXIT
          END
$ LINK/NOMAP TOUSA
$
$ ASSIGN/USER 'P1' FOR005
$ ASSIGN/USER 'P2' FOR007
$ ASSIGN/USER 'P3' FOR008
$ ASSIGN/USER 'P4' FOR006
$
$ RUN TOUSA.EXE
$
$ DELETE/NOCONF TOUSA.OBJ;*
$ EXIT
```

Example Batch File

```
$ ACCUMULATE AAA
$ TRANSFORM1 ! ************** TRANSFORMS FILE FROM G'S TO M/SEC^2**********
1         ! number of prog. cycles
'P1'      ! name of input Data File
CH        ! name of GEDAP output data File [.001]
9.81      ! transformation constant A [1] for eq. y=Ax + B
0.0       ! transformation constant B [0]
$ RUN EXE:FILTV2 ! **** FILTERS TIME SERIES **********************************
1         ! number of program cycles [1]
CH        ! input file containing time series [.001]
CH_F      ! output file containing filtered time series [.001]
0         ! weighting option British Standard z - weighting
          ! resampling option [0]
$ STAT4   ! ********* CALCULATES RMS, MIN, MAX, ETC. ********************
1         ! number of program cycles [1]
CH_F      ! name of input file [.001]
          ! confidence level for interval estimates (percent) [95.0]
$ RUN EXE:CREST3 !**CALCULATES CREST FACTOR, VDV, eVDV, and high order stats*
1         ! number of program cycles [1]
CH_F      ! input file containing time series [.001]
CH_F      ! output file containing time series [.001]
$ STAT2   !** CALCULATES PROBABILITY DENSITY, ETC. **********************
1         ! number of program cycles [1]
CH_F      ! input file containing time series [.001]
DENS      ! prefix for output files: DENS_PDH, DENS_CDH, DENS_PDG, DENS_CDG
50        ! no. of cells
1         ! cell width option
yes       ! apply a Gaussian goodness-of-fit test?
$ RUN EXE:IMPULSE !*** CALCULATES IMPULSIVENESS ******************************
1         ! number of program cycles [1]
DENS_CDH ! input file containing cumulative probability distribution
DENS_CDH ! output file containing cumulative probability distribution
$ VSD     ! ******* CALCULATES SPECTRAL DENSITY FUNCTION ****************
1         ! number of program cycles [1]
CH_F      ! name of time series input file [.001]
          ! name of spectral density output file [CH_F_SPEC.001]
NO        ! Use default parameters? [Yes]:
          ! data window option [1]
.1        ! Alpha (0.0 to 0.5) [0.0]
          ! filter bandwidth in Hz (or 0.0 to specify dof instead) [0.0]
20        ! dof = degrees of freedom per spectral estimate [20]
          ! F1 = low frequency limit (Hz) [0.0]
          ! F2 = high frequency limit (Hz) [Nyquist frequency]
Y         ! Generate 80% confidence interval file? [No]:
          ! Generate spectral parameter files? [No]:
$ RUN EXE:ISO  !***** 1/3 OCTAVE ANALYSIS **********************************
1           !number of program cycles [1]
ch_f_spec   !name of input file [.001]
ch_f_spec   !name of output file [.001]
$ RUN EXE:SPECF !**CALCULATES CREST FACTOR, SPECF OF THIRD OCTAVE SPECTRUM**
dens_cdh    ! input file containing cumulative density, and I(.97)
ch_f_spec   ! input file containing time series [.001]
ch_f_specF ! output file containing filtered time series [.001]
'P1'        ! run file name
'P2'        ! speed
'P3'        ! road type
'P4'        ! accel axis direction
$ ACCUMULATE OFF
$!
$ EXPORT_PAR2
AAA     ! name of Header Parameter input file
1       ! channel no.
14      ! no. of parameters to be collected
SIGNAL_TYPE
OB_RMTT_RMS
```

```
SPECF
SPEED
CREST_FACTOR
STAT_MAX
STAT_MIN
STAT_STD_DEV
RMQ
RMTT
VRV60
VDV60
VTTV60
PZ.DAT     ! NAME OF ASCII FILE
$ DELETE/NOCONFIRM AAA.00%;*
$ DELETE/NOCONFIRM ch*.*;*
$ DELETE/NOCONFIRM dens*.*;*
$ EXIT
```

Appendix D

Seat Motion Data

(Note: Apendixes D-1 to D-23 are bound separately)

Appendix	Vehicle	Analysis Method
D-1	FAV	BS-6841*
D-2	M2 Bradley	BS-6841
D-3	M1A1	ISO-2631**
D-4	M1A1	BS-6841
D-5	M1A1	FG***
D-6	M1A1 HTT	ISO-2631
D-7	M1A1 HTT	BS-6841
D-8	M1A1 HTT	FG
D-9	M1026 HMMWV	ISO-2631
D-10	M1026 HMMWV	BS-6841
D-11	M1026 HMMWV	FG
D-12	M109A3	ISO-2631
D-13	M109A3	BS-6841
D-14	M109A3	FG
D-15	M923A2	ISO-2631
D-16	M923A2	BS-6841
D-17	M923A2	FG
D-18	XM1076	ISO-2631
D-19	XM1076	BS-6841
D-20	XM1076	FG
D-21	M2HS Bradley	ISO-2631
D-22	M2HS Bradley	BS-6841
D-23	M2HS Bradley	FG

* British Standard 6841

** ISO Standard 2631

*** Fairley-Griffin Model

M1A1

XM1A1COM.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Commander		X			Oct. 6/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
1	2	1.60	1.79	8.83	6" wash brd	5	2.51	3.35	-2.50	1.16	1.37	1.86	9.02	3.82	2.62
3	2	2.03	2.11	5.63	6" wash brd	15	3.39	1.74	-1.96	0.55	0.71	1.11	4.23	1.96	1.56
4	1	2.15	2.23	3.16	paved	5	3.53	0.60	-0.53	0.16	0.21	0.34	1.23	0.59	0.48
8	4	2.69	2.20	2.67	paved	25	4.15	1.32	-0.92	0.27	0.38	0.73	2.09	1.05	1.02
12	1	2.25	2.19	2.78	paved	45	3.79	0.66	-0.73	0.18	0.25	0.41	1.42	0.68	0.58
14	4	3.17	2.31	5.07	XC #3	10	4.04	3.87	-6.57	1.29	2.08	4.10	10.01	5.72	5.76
16	4	2.65	2.32	4.18	XC #3	20	3.89	5.46	-8.56	1.80	2.54	4.77	13.95	7.08	6.71
18	4	3.91	2.27	3.41	secondary	10	5.71	1.84	-0.93	0.24	0.39	0.94	1.87	1.08	1.33
20	4	2.88	2.20	3.56	secondary	20	4.81	1.42	-1.62	0.32	0.47	0.91	2.45	1.31	1.28
22	2	1.97	2.15	6.66	secondary	30	3.30	1.26	-1.26	0.38	0.50	0.75	2.97	1.38	1.06
23	1	2.27	2.19	2.15	gravel	5	3.89	0.74	-0.62	0.18	0.23	0.40	1.36	0.65	0.56
25	1	2.14	2.22	3.13	gravel	15	3.68	0.87	-0.83	0.23	0.31	0.49	1.79	0.86	0.70
27	2	2.39	2.14	5.04	gravel	25	4.38	1.08	-0.88	0.22	0.30	0.54	1.73	0.83	0.75
29	2	2.08	2.17	5.85	gravel	35	3.49	1.00	-0.87	0.27	0.35	0.56	2.08	0.98	0.78
SIGNAL TYPE					N % n										
1	mean	2.20	2.21	2.80	28.57	17.50	3.72	0.72	-0.68	0.19	0.25	0.41	1.45	0.69	0.58
	std. dev	0.07	0.02	0.47			0.15	0.12	0.13	0.03	0.04	0.06	0.24	0.12	0.09
2	mean	2.01	2.07	6.40	35.71	22.00	3.41	1.69	-1.50	0.52	0.64	0.96	4.01	1.79	1.36
	std. dev	0.28	0.16	1.47			0.67	0.97	0.72	0.38	0.44	0.55	2.96	1.21	0.78
3	mean	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	3.06	2.26	3.78	35.71	17.00	4.52	2.78	-3.72	0.78	1.17	2.29	6.07	3.25	3.22
	std. dev	0.52	0.06	0.90			0.75	1.82	3.59	0.72	1.05	1.97	5.57	2.92	2.78

YM1A1COM.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Commander		Y			Oct. 6/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
1	2	2.06	2.22	4.17	6' wash brd	5	3.51	1.42	-1.42	0.40	0.53	0.83	3.13	1.48	1.17
3	2	2.00	2.12	4.26	6' wash brd	15	3.09	1.60	-1.28	0.47	0.60	0.94	3.62	1.68	1.32
4	4	2.93	2.36	3.45	paved	5	4.60	1.03	-0.64	0.18	0.26	0.53	1.40	0.73	0.74
8	1	2.31	2.28	2.53	paved	25	3.59	1.25	-0.85	0.29	0.40	0.68	2.27	1.11	0.95
12	3	2.28	2.33	3.45	paved	45	3.61	0.82	-0.96	0.25	0.34	0.56	1.91	0.94	0.79
14	4	3.64	2.49	4.65	XC #3	10	3.95	2.09	-6.16	1.04	1.87	3.80	8.08	5.08	5.34
16	3	2.43	2.49	3.98	XC #3	20	3.69	6.74	-5.57	1.67	2.42	4.05	12.93	6.73	5.70
18	4	3.16	2.39	2.95	secondary	10	5.24	1.67	-1.27	0.28	0.43	0.88	2.17	1.19	1.24
20	1	2.29	2.26	2.99	secondary	20	3.52	1.82	-1.32	0.45	0.60	1.02	3.46	1.68	1.44
22	1	2.01	2.23	3.90	secondary	30	3.27	1.43	-1.66	0.47	0.62	0.95	3.66	1.73	1.34
23	1	2.19	2.26	2.36	gravel	5	3.82	0.81	-0.78	0.21	0.28	0.45	1.60	0.78	0.64
25	1	2.40	2.24	2.95	gravel	15	3.82	0.79	-1.13	0.25	0.34	0.61	1.95	0.95	0.85
27	4	2.91	2.16	3.49	gravel	25	4.77	1.30	-1.55	0.30	0.44	0.87	2.31	1.22	1.22
29	2	2.27	2.23	6.96	gravel	35	3.88	1.95	-1.56	0.45	0.61	1.03	3.50	1.70	1.44
SIGNAL TYPE					N % n										
1	mean	2.24	2.25	2.95	35.71	19.00	3.61	1.22	-1.15	0.33	0.45	0.74	2.59	1.25	1.04
	std. dev	0.15	0.02	0.60			0.23	0.44	0.36	0.12	0.16	0.24	0.92	0.43	0.34
2	mean	2.11	2.19	5.13	21.43	18.33	3.49	1.66	-1.42	0.44	0.58	0.93	3.41	1.62	1.31
	std. dev	0.14	0.06	1.59			0.40	0.27	0.14	0.03	0.04	0.10	0.25	0.12	0.14
3	mean	2.36	2.41	3.71	14.29	32.50	3.65	3.78	-3.27	0.96	1.38	2.31	7.42	3.83	3.25
	std. dev	0.10	0.12	0.38			0.05	4.18	3.26	1.01	1.47	2.47	7.79	4.09	3.47
4	mean	3.16	2.35	3.64	28.57	12.50	4.64	1.52	-2.40	0.45	0.75	1.52	3.49	2.06	2.14
	std. dev	0.34	0.14	0.72			0.53	0.46	2.53	0.40	0.75	1.53	3.09	2.03	2.15

ZM1A1COM.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Commander		Z			Feb. 16/93					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
1	4	3.359	2.023	2.961	6" wash brd	5	5.186	4.516	-7.338	1.143	1.629	3.838	8.852	4.533	5.399
3	2	2.009	2.092	5.407	6" wash brd	15	2.848	5.356	-7.215	2.207	2.910	4.435	17.094	8.099	6.238
4	4	2.648	2.244	3.767	paved	5	4.792	1.526	-1.574	0.323	0.461	0.856	2.506	1.282	1.205
8	1	2.074	2.145	3.455	paved	25	3.793	1.731	-1.864	0.474	0.616	0.983	3.671	1.713	1.383
12	1	2.406	2.197	3.116	paved	45	4.103	1.359	-1.621	0.363	0.492	0.874	2.813	1.369	1.229
14	4	3.346	2.456	2.199	XC #3	10	6.053	6.566	-5.490	0.996	1.558	3.333	7.715	4.339	4.688
16	4	4.286	2.304	2.004	XC #3	20	7.679	30.321	-36.059	4.322	7.700	18.523	33.479	21.430	26.055
18	4	9.734	1.955	2.759	secondary	10	16.116	6.041	-10.977	0.528	1.373	5.139	4.090	3.822	7.229
20	1	2.338	2.164	3.882	secondary	20	4.245	2.506	-2.113	0.544	0.727	1.272	4.215	2.024	1.789
22	2	2.468	2.129	5.682	secondary	30	4.381	2.935	-4.036	0.796	1.044	1.963	6.163	2.906	2.762
23	2	2.255	2.146	4.039	gravel	5	3.753	1.402	-1.790	0.425	0.560	0.959	3.294	1.558	1.349
25	2	2.207	2.175	5.059	gravel	15	3.779	1.547	-1.659	0.424	0.565	0.936	3.285	1.571	1.317
27	2	2.203	2.269	4.957	gravel	25	3.855	1.720	-1.780	0.454	0.611	1.000	3.516	1.701	1.407
29	4	2.507	2.183	7.016	gravel	35	4.705	2.690	-3.143	0.620	0.830	1.554	4.802	2.310	2.186
SIGNAL TYPE					N % n										
1	mean	2.27	2.17	3.48	21.43	30.00	4.05	1.87	-1.87	0.46	0.61	1.04	3.57	1.70	1.47
	std. dev	0.18	0.03	0.38			0.23	0.59	0.25	0.09	0.12	0.21	0.71	0.33	0.29
2	mean	2.23	2.16	5.03	35.71	18.00	3.72	2.59	-3.30	0.86	1.14	1.86	6.67	3.17	2.61
	std. dev	0.16	0.07	0.62			0.55	1.66	2.41	0.77	1.01	1.50	5.95	2.81	2.12
3	mean	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	4.31	2.19	3.45	42.86	14.17	7.42	8.61	-10.76	1.32	2.26	5.54	10.24	6.29	7.79
	std. dev	2.73	0.18	1.85			4.40	10.81	12.82	1.50	2.70	6.55	11.62	7.52	9.21

XM1A1DRV.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Driver		X			Oct. 6/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
1	2	1.97	2.11	6.15	6' wash brd	5	2.92	1.92	-1.47	0.58	0.75	1.14	4.50	2.09	1.61
3	2	1.58	1.79	8.76	6' wash brd	15	2.47	1.85	-1.81	0.74	0.87	1.17	5.74	2.42	1.65
4	3	2.31	2.42	2.80	paved	5	3.90	0.52	-0.51	0.13	0.19	0.31	1.03	0.52	0.43
8	1	2.41	2.24	2.85	paved	25	3.69	0.96	-0.78	0.24	0.32	0.57	1.83	0.90	0.80
12	1	2.15	2.20	3.21	paved	45	3.55	0.51	-0.70	0.17	0.23	0.37	1.33	0.63	0.52
14	4	4.62	2.48	4.47	XC #3	10	5.07	15.48	-5.55	2.08	4.50	9.60	16.08	12.30	13.50
16	4	4.60	2.32	4.18	XC #3	20	5.48	22.60	-7.06	2.71	4.92	12.44	20.97	13.70	17.50
18	4	4.89	2.16	2.45	secondary	10	6.06	1.80	-0.50	0.19	0.34	0.93	1.47	0.94	1.31
20	3	2.41	2.32	3.66	secondary	20	3.82	1.11	-0.95	0.27	0.38	0.65	2.09	1.06	0.91
22	4	2.73	2.50	3.86	secondary	30	4.21	0.97	-1.22	0.26	0.39	0.71	2.02	1.08	1.00
23	1	2.20	2.21	2.61	gravel	5	3.44	0.55	-0.50	0.15	0.21	0.34	1.19	0.57	0.47
25	1	2.20	2.28	3.00	gravel	15	3.56	0.76	-0.77	0.22	0.29	0.47	1.67	0.82	0.67
27	2	1.99	2.16	2.31	gravel	25	3.20	0.56	-0.46	0.16	0.21	0.32	1.24	0.58	0.45
29	2	1.99	2.19	2.78	gravel	35	3.17	0.58	-0.55	0.18	0.23	0.35	1.38	0.65	0.50
SIGNAL TYPE					N % n										
1	mean	2.24	2.23	2.92	28.57	22.50	3.56	0.70	-0.69	0.19	0.26	0.44	1.50	0.73	0.61
	std. dev	0.12	0.04	0.25			0.10	0.21	0.13	0.04	0.06	0.11	0.30	0.16	0.15
2	mean	1.88	2.06	5.00	28.57	20.00	2.94	1.23	-1.07	0.41	0.51	0.75	3.21	1.43	1.05
	std. dev	0.20	0.18	3.04			0.34	0.76	0.67	0.29	0.34	0.47	2.26	0.96	0.67
3	mean	2.36	2.37	3.23	14.29	12.50	3.86	0.82	-0.73	0.20	0.28	0.48	1.56	0.79	0.67
	std. dev	0.07	0.07	0.61			0.05	0.42	0.31	0.10	0.14	0.24	0.75	0.38	0.34
4	mean	4.21	2.36	3.74	28.57	17.50	5.20	10.21	-3.58	1.31	2.54	5.92	10.14	7.01	8.33
	std. dev	1.00	0.16	0.89			0.78	10.60	3.22	1.28	2.51	6.00	9.89	6.94	8.44

YM1A1DRV.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Driver		Y			Oct. 6/92					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
													RMS	RMQ	RMT
1	2	2.00	2.06	4.79	6" wash brd	5	3.06	1.68	-1.33	0.49	0.64	0.98	3.81	1.79	1.38
3	2	1.90	1.98	5.88	6" wash brd	15	2.65	1.33	-0.94	0.43	0.54	0.81	3.31	1.50	1.14
4	3	2.41	2.34	2.69	paved	5	3.42	0.57	-0.39	0.14	0.20	0.34	1.08	0.55	0.47
8	4	2.60	2.29	2.95	paved	25	3.72	1.01	-0.73	0.23	0.33	0.61	1.80	0.92	0.85
12	1	2.08	2.17	3.05	paved	45	3.32	0.50	-0.57	0.16	0.21	0.34	1.25	0.59	0.47
14	4	4.53	2.56	5.42	XC #3	10	4.95	9.48	-3.33	1.30	2.76	5.87	10.03	7.56	8.25
16	3	2.35	2.39	3.11	XC #3	20	3.66	5.17	-3.90	1.24	1.72	2.92	9.61	4.79	4.10
18	3	2.17	2.31	3.08	secondary	10	3.42	0.48	-0.57	0.15	0.21	0.33	1.19	0.58	0.47
20	1	2.11	2.29	3.39	secondary	20	3.29	1.02	-0.90	0.29	0.39	0.62	2.26	1.09	0.87
22	1	2.18	2.06	3.23	secondary	30	3.56	1.03	-0.66	0.24	0.30	0.52	1.85	0.85	0.73
23	1	2.16	2.20	2.06	gravel	5	3.65	0.52	-0.43	0.13	0.17	0.28	1.01	0.48	0.40
25	1	2.09	2.30	3.31	gravel	15	3.34	0.69	-0.77	0.22	0.29	0.46	1.69	0.81	0.64
27	4	2.51	2.40	2.75	gravel	25	3.62	0.55	-0.77	0.18	0.26	0.46	1.41	0.72	0.64
29	2	1.98	2.28	2.88	gravel	35	3.08	0.74	-0.72	0.24	0.32	0.47	1.83	0.88	0.66
SIGNAL TYPE					N % n										
1	mean	2.13	2.20	3.01	35.71	23.00	3.43	0.75	-0.67	0.21	0.27	0.44	1.61	0.76	0.62
	std. dev	0.04	0.10	0.54			0.16	0.26	0.18	0.06	0.09	0.14	0.50	0.24	0.19
2	mean	1.96	2.11	4.51	21.43	18.33	2.93	1.25	-0.99	0.39	0.50	0.75	2.98	1.39	1.06
	std. dev	0.05	0.15	1.52			0.24	0.47	0.31	0.13	0.17	0.26	1.03	0.46	0.37
3	mean	2.31	2.34	2.96	21.43	11.67	3.50	2.07	-1.62	0.51	0.71	1.20	3.96	1.97	1.68
	std. dev	0.12	0.04	0.24			0.14	2.68	1.98	0.63	0.88	1.49	4.89	2.44	2.09
4	mean	3.21	2.42	3.71	21.43	20.00	4.10	3.68	-1.61	0.57	1.12	2.31	4.41	3.06	3.25
	std. dev	1.14	0.14	1.49			0.74	5.03	1.49	0.63	1.43	3.08	4.87	3.90	4.34

ZM1A1DRV.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Driver		Z			Feb. 16/93					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
1	1	2.033	2.065	3.138	6' wash brd	5	2.989	2.521	-1.686	0.704	0.906	1.431	5.451	2.525	2.013
3	2	1.634	1.902	7.654	6' wash brd	15	2.560	2.897	-2.794	1.111	1.341	1.816	8.607	3.733	2.554
4	4	2.709	2.388	3.522	paved	5	4.509	0.811	-0.608	0.157	0.229	0.426	1.219	0.639	0.600
8	1	2.362	2.216	2.140	paved	25	4.368	1.163	-1.057	0.254	0.342	0.600	1.968	0.953	0.844
12	1	2.358	2.247	2.004	paved	45	4.162	0.691	-0.785	0.177	0.241	0.418	1.373	0.671	0.588
14	3	3.995	2.636	2.338	XC #3	10	5.313	4.257	-1.871	0.577	1.019	2.304	4.467	2.814	3.240
16	4	8.472	2.088	2.206	XC #3	20	11.431	37.726	-15.926	2.347	6.649	19.883	18.178	18.507	27.967
18	4	10.000	1.910	2.590	secondary	10	12.258	4.374	-0.953	0.217	0.627	2.173	1.683	1.744	3.056
20	1	2.338	2.228	2.919	secondary	20	3.831	1.345	-0.992	0.305	0.413	0.713	2.363	1.150	1.003
22	4	8.147	2.279	1.835	secondary	30	10.962	4.462	-1.203	0.258	0.564	2.105	2.002	1.568	2.961
23	2	2.440	2.186	4.151	gravel	5	4.382	1.381	-1.461	0.324	0.434	0.791	2.512	1.209	1.113
25	2	2.344	2.209	4.107	gravel	15	4.020	0.796	-1.086	0.234	0.313	0.549	1.814	0.871	0.772
27	1	2.188	2.149	2.420	gravel	25	3.974	0.816	-0.888	0.214	0.283	0.469	1.660	0.788	0.659
29	1	2.233	2.194	2.038	gravel	35	3.954	0.751	-0.847	0.202	0.269	0.451	1.565	0.748	0.635
SIGNAL TYPE					N % n										
1	mean	2.25	2.18	2.44	42.86	25.83	3.88	1.21	-1.04	0.31	0.41	0.68	2.40	1.14	0.96
	std. dev	0.13	0.07	0.48			0.47	0.69	0.33	0.20	0.25	0.38	1.54	0.70	0.54
2	mean	2.14	2.10	5.30	21.43	11.67	3.65	1.69	-1.78	0.56	0.70	1.05	4.31	1.94	1.48
	std. dev	0.44	0.17	2.04			0.96	1.08	0.90	0.48	0.56	0.67	3.74	1.56	0.95
3	mean	3.99	2.64	2.34	7.14	10.00	5.31	4.26	-1.87	0.58	1.02	2.30	4.47	2.81	3.24
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	7.33	2.17	2.54	28.57	16.25	9.79	11.84	-4.67	0.74	2.02	6.15	5.77	5.61	8.65
	std. dev	3.19	0.21	0.72			3.56	17.34	7.51	1.07	3.09	9.19	8.28	8.61	12.93

XM1A1GUN.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Gunner		X			Oct. 6/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
1	2	1.66	1.94	8.20	6" wash brd	5	2.44	2.20	-2.06	0.87	1.07	1.45	6.77	2.98	2.04
3	2	1.70	1.98	6.30	6" wash brd	15	2.60	1.79	-1.73	0.68	0.83	1.15	5.24	2.30	1.62
4	1	2.12	2.17	3.83	paved	5	3.37	0.56	-0.49	0.16	0.20	0.33	1.21	0.57	0.46
8	4	2.73	2.27	2.68	paved	25	3.96	1.08	-0.70	0.23	0.32	0.61	1.74	0.90	0.87
12	1	2.10	2.19	2.18	paved	45	3.39	0.53	-0.60	0.17	0.22	0.35	1.29	0.61	0.49
14	4	4.57	2.41	5.12	XC #3	10	4.96	13.89	-4.71	1.87	4.00	8.56	14.52	10.94	12.04
16	2	1.90	2.21	5.16	XC #3	20	2.82	13.29	-11.92	4.47	5.86	8.52	34.65	16.31	11.98
18	4	3.47	2.23	2.78	secondary	10	4.78	1.25	-0.70	0.20	0.33	0.71	1.58	0.93	0.99
20	1	2.07	2.24	2.99	secondary	20	3.50	0.94	-0.90	0.26	0.35	0.54	2.04	0.98	0.77
22	4	2.94	2.15	2.22	secondary	30	4.70	1.21	-0.71	0.20	0.28	0.60	1.58	0.77	0.84
23	1	2.20	2.19	3.64	gravel	5	3.59	0.75	-0.67	0.20	0.26	0.43	1.53	0.73	0.61
25	1	2.10	2.24	2.75	gravel	15	3.46	0.69	-0.72	0.20	0.27	0.43	1.58	0.76	0.60
27	1	2.32	2.23	1.90	gravel	25	4.04	0.66	-0.68	0.17	0.22	0.38	1.28	0.62	0.54
29	1	2.09	2.19	2.51	gravel	35	3.51	0.75	-0.81	0.22	0.29	0.47	1.73	0.82	0.66
SIGNAL TYPE					N % n										
1	mean	2.14	2.21	2.83	50.00	21.43	3.55	0.70	-0.70	0.20	0.26	0.42	1.52	0.73	0.59
	std. dev	0.09	0.03	0.72			0.23	0.14	0.14	0.04	0.05	0.07	0.30	0.14	0.10
2	mean	1.76	2.04	6.55	21.43	13.33	2.62	5.76	-5.24	2.01	2.59	3.71	15.55	7.20	5.21
	std. dev	0.13	0.15	1.53			0.19	6.53	5.79	2.14	2.84	4.17	16.56	7.90	5.86
3	mean	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	3.43	2.27	3.20	28.57	18.75	4.60	4.36	-1.71	0.63	1.23	2.62	4.85	3.38	3.69
	std. dev	0.82	0.11	1.30			0.44	6.36	2.00	0.83	1.84	3.96	6.44	5.04	5.57

YM1A1GUN.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Gunner		Y			Oct. 6/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
1	2	1.95	2.19	5.81	6" wash brd	5	3.15	1.74	-1.92	0.58	0.75	1.13	4.50	2.09	1.59
3	2	1.70	1.89	7.17	6" wash brd	15	2.54	1.86	-1.33	0.63	0.76	1.07	4.86	2.11	1.50
4	1	2.47	2.19	3.66	paved	5	3.72	0.73	-0.48	0.16	0.22	0.40	1.27	0.62	0.57
8	3	2.35	2.31	3.00	paved	25	3.46	0.83	-0.61	0.21	0.29	0.49	1.61	0.80	0.69
12	1	2.41	2.25	2.92	paved	45	4.33	0.69	-0.82	0.17	0.24	0.42	1.34	0.66	0.59
14	4	2.95	2.38	3.80	XC #3	10	4.07	3.02	-2.02	0.62	0.94	1.82	4.80	2.62	2.57
16	4	3.03	2.12	4.58	XC #3	20	3.85	7.01	-3.38	1.35	1.98	4.09	10.45	5.54	5.75
18	4	2.51	2.24	4.09	secondary	10	4.27	0.94	-0.91	0.22	0.30	0.54	1.68	0.84	0.76
20	1	2.17	2.20	2.71	secondary	20	3.33	1.19	-0.87	0.31	0.41	0.67	2.39	1.14	0.94
22	1	2.09	2.26	3.24	secondary	30	3.26	0.88	-1.11	0.31	0.41	0.64	2.36	1.13	0.90
23	1	2.13	2.15	2.95	gravel	5	3.49	0.67	-0.51	0.17	0.22	0.36	1.31	0.61	0.51
25	1	2.24	2.25	3.10	gravel	15	3.49	0.62	-0.68	0.19	0.25	0.42	1.45	0.71	0.59
27	4	3.03	2.24	2.51	gravel	25	4.25	0.67	-1.07	0.20	0.31	0.62	1.59	0.85	0.87
29	1	2.15	2.24	2.58	gravel	35	3.33	0.97	-0.69	0.25	0.33	0.54	1.93	0.94	0.75
SIGNAL TYPE					N % n										
1	mean	2.24	2.22	3.02	50.00	22.14	3.56	0.82	-0.74	0.22	0.30	0.49	1.72	0.83	0.69
	std. dev	0.15	0.04	0.36			0.37	0.20	0.22	0.06	0.08	0.12	0.50	0.24	0.17
2	mean	1.82	2.04	6.49	14.29	10.00	2.85	1.80	-1.62	0.60	0.75	1.10	4.68	2.10	1.55
	std. dev	0.18	0.21	0.96			0.43	0.08	0.42	0.03	0.01	0.05	0.26	0.02	0.07
3	mean	2.35	2.31	3.00	7.14	25.00	3.46	0.83	-0.61	0.21	0.29	0.49	1.61	0.80	0.69
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	2.88	2.24	3.74	28.57	16.25	4.11	2.91	-1.84	0.60	0.89	1.77	4.63	2.46	2.49
	std. dev	0.25	0.11	0.88			0.20	2.93	1.14	0.54	0.79	1.65	4.16	2.22	2.33

ZM1A1GUN.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Gunner		Z			Feb. 16/93					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
1	2	1.815	1.976	2.933	6' wash brd	5	3.094	3.174	-3.474	1.074	1.328	1.949	8.321	3.697	2.742
3	2	2.023	2.067	4.659	6' wash brd	15	3.046	3.679	-4.440	1.333	1.747	2.696	10.325	4.862	3.792
4	1	2.290	2.199	3.494	paved	5	4.063	1.148	-1.094	0.276	0.370	0.632	2.137	1.029	0.889
8	2	2.157	2.105	5.593	paved	25	4.071	3.360	-2.963	0.777	1.001	1.675	6.015	2.786	2.356
12	1	2.164	2.176	3.351	paved	45	3.933	1.605	-1.805	0.434	0.570	0.938	3.358	1.586	1.320
14	4	4.200	2.229	2.310	XC #3	10	5.980	7.496	-3.720	0.938	1.539	3.939	7.264	4.264	5.541
16	4	6.071	2.137	2.178	XC #3	20	9.517	37.510	-25.031	3.286	7.682	19.945	25.450	21.388	28.055
18	4	9.567	1.957	2.905	secondary	10	19.102	8.213	-8.703	0.443	1.231	4.236	3.430	3.426	5.959
20	3	2.382	2.329	4.799	secondary	20	4.250	2.375	-2.367	0.558	0.779	1.329	4.321	2.170	1.869
22	2	2.359	2.225	4.594	secondary	30	4.070	2.034	-2.442	0.550	0.744	1.297	4.260	2.072	1.825
23	2	1.884	2.037	5.295	gravel	5	3.096	1.714	-1.755	0.560	0.706	1.055	4.339	1.967	1.484
25	2	2.104	2.136	4.660	gravel	15	3.562	1.137	-1.281	0.339	0.442	0.714	2.630	1.231	1.005
27	2	2.240	2.206	4.485	gravel	25	4.164	1.741	-1.632	0.405	0.541	0.907	3.137	1.506	1.276
29	4	2.552	2.170	2.827	gravel	35	4.722	1.604	-1.895	0.371	0.498	0.945	2.870	1.388	1.330
SIGNAL TYPE					N % n										
1	mean	2.23	2.19	3.42	14.29	25.00	4.00	1.38	-1.45	0.35	0.47	0.78	2.75	1.31	1.10
	std. dev	0.09	0.02	0.10			0.09	0.32	0.50	0.11	0.14	0.22	0.86	0.39	0.30
2	mean	2.08	2.11	4.60	50.00	17.14	3.59	2.41	-2.57	0.72	0.93	1.47	5.58	2.59	2.07
	std. dev	0.19	0.09	0.84			0.51	0.98	1.13	0.37	0.47	0.69	2.83	1.30	0.97
3	mean	2.38	2.33	4.80	7.14	20.00	4.25	2.38	-2.37	0.56	0.78	1.33	4.32	2.17	1.87
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	5.60	2.12	2.56	28.57	18.75	9.83	13.71	-9.84	1.26	2.74	7.27	9.75	7.62	10.22
	std. dev	3.01	0.12	0.36			6.51	16.14	10.53	1.37	3.32	8.58	10.64	9.26	12.07

XM1A1LOD.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Loader		X			Oct. 6/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
1	2	1.69	1.95	6.50	6" wash brd	5	2.58	1.86	-1.79	0.71	0.86	1.19	5.47	2.39	1.68
3	2	1.65	1.85	7.36	6" wash brd	15	2.59	2.02	-1.73	0.72	0.87	1.19	5.59	2.41	1.68
4	3	3.35	2.67	4.19	paved	5	5.09	1.50	-1.26	0.27	0.47	0.91	2.10	1.30	1.28
8	1	2.16	2.21	2.29	paved	25	3.61	1.00	-0.81	0.25	0.33	0.54	1.95	0.93	0.76
12	1	2.27	2.22	2.84	paved	45	4.03	0.87	-1.06	0.24	0.32	0.54	1.85	0.89	0.76
14	4	2.99	2.58	4.60	XC #3	10	4.05	3.79	-2.34	0.76	1.22	2.27	5.86	3.36	3.19
16	3	2.36	2.36	3.30	XC #3	20	3.68	4.55	-4.08	1.17	1.65	2.76	9.07	4.61	3.88
18	4	3.77	2.22	2.17	secondary	10	6.72	1.87	-1.79	0.27	0.45	1.03	2.11	1.26	1.45
20	3	2.31	2.32	2.72	secondary	20	4.03	1.32	-1.10	0.30	0.41	0.69	2.32	1.14	0.97
22	3	2.20	2.33	2.85	secondary	30	3.49	1.40	-1.20	0.37	0.52	0.82	2.90	1.43	1.15
23	1	2.31	2.18	2.55	gravel	5	4.05	0.81	-0.77	0.20	0.26	0.45	1.51	0.73	0.63
25	4	2.54	2.39	2.64	gravel	15	3.82	1.16	-0.94	0.27	0.40	0.70	2.13	1.10	0.98
27	4	2.88	2.55	2.55	gravel	25	4.38	1.52	-1.12	0.30	0.46	0.87	2.33	1.28	1.22
29	2	2.09	2.16	6.79	gravel	35	3.32	1.87	-1.43	0.50	0.65	1.04	3.86	1.80	1.47
SIGNAL TYPE					N % n										
1	mean	2.25	2.20	2.56	21.40	25.00	3.90	0.89	-0.88	0.23	0.31	0.51	1.77	0.85	0.72
	std. dev	0.08	0.02	0.28		20.00	0.25	0.10	0.16	0.03	0.04	0.05	0.23	0.11	0.08
2	mean	1.81	1.98	6.88	21.40	18.33	2.83	1.92	-1.65	0.64	0.79	1.14	4.98	2.20	1.61
	std. dev	0.24	0.15	0.44		15.28	0.42	0.09	0.19	0.13	0.12	0.09	0.97	0.35	0.12
3	mean	2.55	2.42	3.27	28.75	18.75	4.07	2.19	-1.91	0.53	0.76	1.29	4.10	2.12	1.82
	std. dev	0.54	0.17	0.67		10.31	0.71	1.57	1.45	0.43	0.59	0.98	3.33	1.66	1.38
4	mean	3.04	2.43	2.99	28.75	15.00	4.74	2.08	-1.55	0.40	0.63	1.21	3.11	1.75	1.71
	std. dev	0.52	0.17	1.09		7.07	1.34	1.17	0.64	0.24	0.39	0.71	1.84	1.08	1.00

YM1A1LOD.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Loader		Y			Oct. 6/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
1	2	1.68	1.96	8.10	6" wash brd	5	2.42	2.25	-1.97	0.87	1.07	1.46	6.74	2.99	2.056
3	2	1.83	2.03	6.50	6" wash brd	15	3.07	1.67	-1.76	0.56	0.70	1.02	4.33	1.95	1.435
4	4	3.28	2.33	3.67	paved	5	4.94	0.91	-1.23	0.22	0.34	0.71	1.68	0.95	1.001
8	1	2.45	2.16	2.54	paved	25	3.76	0.94	-0.70	0.22	0.30	0.54	1.69	0.83	0.7541
12	2	2.08	2.20	7.09	paved	45	3.49	0.85	-1.05	0.27	0.36	0.56	2.10	0.99	0.7925
14	4	4.47	2.48	5.92	XC #3	10	4.98	12.27	-4.78	1.71	3.62	7.65	13.25	9.93	10.75
16	4	2.52	2.51	4.38	XC #3	20	3.97	7.49	-9.01	2.08	3.01	5.24	16.11	8.40	7.366
18	4	3.81	2.23	2.50	secondary	10	5.43	1.43	-0.67	0.19	0.31	0.74	1.50	0.85	1.036
20	4	2.58	2.36	3.49	secondary	20	4.19	1.16	-1.03	0.26	0.38	0.67	2.02	1.06	0.9486
22	3	2.11	2.31	1.97	secondary	30	3.49	0.84	-0.80	0.24	0.32	0.49	1.82	0.88	0.6959
23	1	2.33	2.26	2.36	gravel	5	3.74	0.59	-0.77	0.18	0.24	0.42	1.40	0.68	0.5923
25	4	3.60	2.06	2.63	gravel	15	4.89	0.90	-1.53	0.25	0.41	0.90	1.93	1.13	1.26
27	4	2.60	2.24	2.16	gravel	25	3.88	0.93	-0.58	0.19	0.27	0.51	1.51	0.76	0.7133
29	1	2.34	2.23	3.62	gravel	35	3.55	0.96	-0.70	0.23	0.32	0.55	1.81	0.88	0.7688
SIGNAL TYPE					N % n										
1	mean	2.37	2.22	2.84	18.75	21.67	3.69	0.83	-0.72	0.21	0.29	0.50	1.63	0.80	0.71
	std. dev	0.20	0.12	0.81		20.82	0.54	0.70	0.48	0.30	0.36	0.45	2.32	1.00	0.63
2	mean	1.86	2.06	7.23	18.75	21.67	3.00	1.59	-1.59	0.57	0.71	1.01	4.39	1.98	1.43
	std. dev	0.20	0.12	0.81		20.82	0.54	0.70	0.48	0.30	0.36	0.45	2.32	1.00	0.63
3	mean	2.11	2.31	1.97	6.25	30.00	3.49	0.84	-0.80	0.24	0.32	0.49	1.82	0.88	0.70
	std. dev	n/a	n/a	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	3.27	2.32	3.54	43.75	15.00	4.61	3.58	-2.69	0.70	1.19	2.34	5.43	3.30	3.30
	std. dev	0.74	0.15	1.30		7.07	0.59	4.52	3.14	0.82	1.46	2.89	6.38	4.03	4.06

ZM1A1LOD.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Loader		Z			Feb. 16/93					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
1	1	2.121	2.113	2.908	6" wash brd	5	3.426	3.475	-4.914	1.224	1.578	2.597	9.484	4.392	3.653
3	2	2.010	1.946	5.175	6" wash brd	15	2.977	5.066	-8.301	2.245	2.914	4.513	17.393	8.110	6.348
4	4	2.744	2.243	3.442	paved	5	4.868	1.616	-1.343	0.304	0.428	0.834	2.354	1.191	1.173
8	2	1.694	1.887	7.329	paved	25	2.969	3.035	-3.362	1.077	1.293	1.825	8.345	3.600	2.567
12	2	2.182	2.139	5.269	paved	45	4.056	1.838	-2.009	0.474	0.620	1.035	3.673	1.727	1.456
14	4	3.054	2.471	2.035	XC #3	10	5.231	4.049	-4.918	0.857	1.328	2.618	6.639	3.695	3.682
16	4	5.866	2.105	1.776	XC #3	20	8.731	24.876	-16.595	2.375	5.166	13.930	18.396	14.371	19.595
18	4	5.098	2.085	4.335	secondary	10	7.997	7.851	-4.347	0.763	1.256	3.888	5.907	3.495	5.468
20	2	2.347	2.189	5.167	secondary	20	4.270	4.044	-4.064	0.949	1.273	2.228	7.354	3.542	3.134
22	2	2.316	2.189	4.124	secondary	30	4.515	3.183	-3.060	0.691	0.921	1.601	5.355	2.563	2.252
23	2	1.949	2.098	5.132	gravel	5	3.292	2.378	-2.502	0.741	0.948	1.445	5.742	2.638	2.032
25	4	5.700	2.095	3.873	gravel	15	10.737	5.790	-6.988	0.595	1.274	3.392	4.609	3.545	4.771
27	2	2.176	2.226	7.053	gravel	25	4.082	3.308	-2.985	0.771	1.025	1.677	5.971	2.852	2.359
29	2	2.393	2.168	4.741	gravel	35	4.368	2.677	-2.362	0.577	0.774	1.380	4.468	2.153	1.942
SIGNAL TYPE					N % n										
1	mean	2.12	2.11	2.91	7.14	5.00	3.43	3.48	-4.91	1.22	1.58	2.60	9.48	4.39	3.65
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2	mean	2.13	2.11	5.50	57.14	25.00	3.82	3.19	-3.58	0.94	1.22	1.96	7.29	3.40	2.76
	std. dev	0.24	0.12	1.11			0.64	1.00	2.01	0.56	0.72	1.09	4.34	2.01	1.53
3	mean	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	4.49	2.20	3.09	35.71	12.00	7.51	8.84	-6.84	0.98	1.89	4.93	7.58	5.26	6.94
	std. dev	1.49	0.16	1.13			2.47	9.25	5.82	0.81	1.87	5.16	6.26	5.20	7.26

M1A1 HTT

XM1HTDRV.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1 HIT		Driver		X			Oct. 6/92					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
1	2	2.31	2.26	4.14	gravel	5	3.69	0.31	-0.29	0.08	0.11	0.19	0.63	0.31	0.26
2	1	2.27	2.22	3.28	gravel	10	3.68	0.33	-0.31	0.09	0.12	0.20	0.67	0.33	0.28
3	1	2.14	2.23	3.01	gravel	15	3.49	0.25	-0.29	0.08	0.10	0.17	0.60	0.29	0.23
4	1	2.07	2.21	3.00	gravel	20	3.08	0.20	-0.24	0.07	0.09	0.15	0.55	0.26	0.21
5	1	2.09	2.19	3.16	gravel	25	3.20	0.21	-0.24	0.07	0.09	0.15	0.55	0.26	0.21
6	4	5.51	2.32	3.00	gravel	30	7.33	1.08	-2.39	0.24	0.55	1.31	1.83	1.52	1.84
7	3	2.19	2.46	3.19	gravel	35	3.35	0.28	-0.23	0.08	0.11	0.17	0.59	0.29	0.24
8	4	3.12	2.46	3.11	paved	5	4.99	0.23	-0.25	0.05	0.08	0.15	0.38	0.22	0.21
9	3	2.14	2.31	3.54	paved	10	3.05	0.20	-0.14	0.06	0.08	0.12	0.44	0.21	0.17
10	3	2.77	2.73	3.48	paved	15	4.24	0.22	-0.27	0.06	0.09	0.16	0.45	0.25	0.22
11	1	2.22	2.20	3.80	paved	20	3.06	0.29	-0.19	0.08	0.11	0.17	0.61	0.29	0.25
12	2	1.86	2.10	5.31	paved	25	2.71	0.27	-0.25	0.10	0.12	0.18	0.74	0.34	0.25
17	2	2.12	2.16	4.01	secondary	5	3.30	0.26	-0.23	0.07	0.10	0.16	0.57	0.27	0.22
18	4	2.93	2.21	3.31	secondary	10	4.50	0.37	-0.32	0.08	0.12	0.23	0.60	0.32	0.32
19	1	2.24	2.29	3.29	secondary	15	3.35	0.27	-0.22	0.07	0.10	0.16	0.56	0.27	0.23
20	3	2.08	2.43	5.05	secondary	20	3.03	0.45	-0.38	0.14	0.19	0.28	1.05	0.52	0.40
21	4	2.65	2.39	6.72	secondary	25	3.41	1.15	-0.75	0.28	0.41	0.74	2.16	1.14	1.04
22	2	1.97	2.32	6.55	secondary	30	2.79	0.98	-0.86	0.33	0.44	0.65	2.55	1.22	0.91
23	3	2.07	2.34	6.28	secondary	35	3.04	1.06	-0.87	0.32	0.43	0.66	2.45	1.20	0.92
24	2	2.47	2.29	5.01	XC #3	5	3.66	0.45	-0.38	0.11	0.16	0.28	0.87	0.45	0.39
25	4	4.12	2.45	5.26	XC #3	5	5.10	1.29	-0.66	0.19	0.37	0.79	1.48	1.02	1.11
26	4	3.21	2.59	4.47	XC #3	10	3.69	1.24	-0.55	0.24	0.40	0.78	1.88	1.12	1.10
27	4	5.51	2.22	5.96	XC #3	15	6.41	9.14	-3.62	1.00	2.32	5.48	7.71	6.42	7.71
28	3	3.11	3.00	5.63	XC #4	5	4.05	7.82	-4.88	1.57	2.67	4.87	12.14	7.43	6.85
29	4	6.40	1.23	5.03	XC #4	10	7.72	12.76	-5.92	1.21	3.32	7.75	9.37	9.24	10.89
30	2	2.08	2.17	4.37	Churchville B	5	3.14	0.25	-0.23	0.08	0.10	0.16	0.59	0.28	0.22
31	3	2.80	2.75	6.18	Churchville B	10	3.87	2.24	-1.81	0.52	0.83	1.46	4.04	2.30	2.05
36	3	4.04	3.07	8.54	Churchville B	15	5.13	7.56	-4.84	1.21	2.47	4.88	9.37	6.85	6.87
37	3	2.89	2.65	7.35	Churchville B	20	3.39	15.60	-7.31	3.38	5.36	9.78	26.17	14.91	13.75
38	3	2.74	2.85	8.93	Churchville B	25	3.62	10.23	-7.79	2.49	4.01	6.81	19.28	11.21	9.57
39	3	2.89	2.60	8.08	Churchville B	30	3.78	13.77	-8.52	2.95	4.57	8.51	22.82	12.69	11.96
40	4	3.57	2.35	8.43	Churchville B	35	4.42	20.60	-9.90	3.45	5.71	12.31	26.70	15.92	17.32
SIGNAL TYPE					N % n										
1	mean	2.17	2.22	3.26	18.75	17.50	3.31	0.26	-0.25	0.08	0.10	0.17	0.59	0.28	0.23
	st. dev	0.08	0.04	0.30		5.24	0.24	0.05	0.04	0.01	0.01	0.02	0.05	0.02	0.03
2	mean	2.13	2.22	4.90	18.75	12.50	3.22	0.42	-0.37	0.13	0.17	0.27	0.99	0.48	0.38
	st. dev	0.22	0.08	0.95		11.73	0.42	0.28	0.25	0.10	0.13	0.19	0.77	0.37	0.27
3	mean	2.70	2.65	6.02	34.38	20.00	3.69	5.40	-3.37	1.16	1.89	3.43	8.98	5.26	4.82
	st. dev	0.57	0.25	2.17		9.44	0.63	5.97	3.44	1.29	2.06	3.76	10.01	5.73	5.28
4	mean	4.12	2.25	5.03	28.13	16.11	5.28	5.32	-2.71	0.75	1.47	3.28	5.79	4.10	4.62

YM1HTDRV.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1 HIT		Driver		Y			Oct. 6/92					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
1	1	2.04	2.23	3.12	gravel	5	3.23	0.29	-0.26	0.08	0.11	0.17	0.65	0.31	0.24
2	1	2.08	2.18	2.75	gravel	10	3.45	0.30	-0.32	0.09	0.12	0.19	0.69	0.33	0.26
3	3	2.09	2.41	2.45	gravel	15	3.18	0.46	-0.45	0.14	0.20	0.30	1.11	0.55	0.42
4	3	2.13	2.37	2.80	gravel	20	3.29	0.46	-0.41	0.13	0.18	0.28	1.02	0.51	0.39
5	4	2.56	2.43	2.59	gravel	25	3.48	0.58	-0.40	0.14	0.20	0.36	1.09	0.57	0.51
6	4	7.45	1.83	2.65	gravel	30	8.33	0.56	-3.27	0.23	0.60	1.71	1.78	1.67	2.41
7	3	2.35	2.57	2.93	gravel	35	3.72	0.61	-0.62	0.17	0.24	0.39	1.28	0.67	0.55
8	1	2.00	2.17	2.21	paved	5	2.93	0.16	-0.19	0.06	0.08	0.12	0.47	0.22	0.17
9	1	2.10	2.23	2.72	paved	10	3.36	0.20	-0.20	0.06	0.08	0.12	0.46	0.22	0.17
10	4	2.54	2.17	2.91	paved	15	3.96	0.20	-0.27	0.06	0.08	0.15	0.45	0.22	0.21
11	2	1.83	2.08	3.07	paved	20	2.88	0.17	-0.18	0.06	0.08	0.11	0.48	0.22	0.16
12	2	1.89	2.11	3.09	paved	25	3.05	0.24	-0.24	0.08	0.10	0.15	0.62	0.28	0.21
17	4	2.86	2.35	3.09	secondary	5	4.07	0.30	-0.39	0.08	0.13	0.24	0.65	0.35	0.34
18	1	2.10	2.30	2.67	secondary	10	3.36	0.23	-0.25	0.07	0.10	0.15	0.55	0.27	0.21
19	1	2.26	2.26	3.00	secondary	15	3.14	0.20	-0.27	0.07	0.10	0.17	0.58	0.28	0.24
20	1	2.27	2.27	3.42	secondary	20	3.54	0.36	-0.43	0.11	0.15	0.25	0.87	0.43	0.36
21	4	2.52	2.21	3.93	secondary	25	3.88	0.46	-0.56	0.13	0.18	0.33	1.02	0.51	0.47
22	1	2.08	2.23	3.74	secondary	30	3.24	0.50	-0.41	0.14	0.19	0.29	1.10	0.52	0.41
23	1	2.17	2.05	2.71	secondary	35	3.27	0.45	-0.61	0.16	0.21	0.35	1.26	0.59	0.50
24	2	1.93	2.13	3.22	XC #3	5	3.01	0.28	-0.28	0.09	0.12	0.18	0.72	0.34	0.25
25	4	3.66	2.26	4.80	XC #3	5	4.39	0.58	-1.25	0.21	0.36	0.76	1.61	0.99	1.07
26	3	3.07	2.84	4.71	XC #3	10	3.67	0.89	-1.54	0.33	0.55	1.01	2.56	1.52	1.42
27	3	4.67	2.65	5.93	XC #3	15	5.88	4.48	-8.29	1.09	2.29	5.08	8.42	6.34	7.14
28	3	2.82	2.79	5.25	XC #4	5	3.49	3.97	-6.74	1.53	2.46	4.32	11.88	6.84	6.07
29	4	5.96	1.56	4.97	XC #4	10	6.84	4.66	-11.89	1.21	3.09	7.21	9.38	8.61	10.14
30	3	2.34	2.42	3.64	Churchville B	5	3.47	0.33	-0.29	0.09	0.13	0.21	0.69	0.35	0.29
31	3	2.27	2.59	7.12	Churchville B	10	3.27	1.62	-1.83	0.53	0.76	1.20	4.09	2.13	1.69
36	3	4.06	2.74	8.14	Churchville B	15	5.52	3.78	-5.19	0.81	1.65	3.30	6.30	4.59	4.64
37	4	2.51	2.54	7.23	Churchville B	20	3.47	7.07	-9.12	2.34	3.47	5.85	18.09	9.68	8.23
38	3	2.60	2.79	8.84	Churchville B	25	3.56	5.57	-6.89	1.75	2.76	4.54	13.56	7.72	6.39
39	4	2.79	2.58	7.90	Churchville B	30	3.62	5.83	-9.47	2.12	3.25	5.91	16.38	9.04	8.31
40	4	3.12	2.43	7.98	Churchville B	35	4.03	7.59	-13.18	2.58	4.06	8.04	19.94	11.33	11.31
SIGNAL TYPE					N % n										
1	mean	2.12	2.21	2.93	28.10	15.56	3.28	0.30	-0.33	0.09	0.13	0.20	0.74	0.35	0.28
	st. dev	0.09	0.07	0.45		10.74	0.18	0.12	0.13	0.04	0.05	0.08	0.28	0.13	0.11
2	mean	1.88	2.11	3.13	9.38	16.67	2.98	0.23	-0.23	0.08	0.10	0.15	0.61	0.28	0.21
	st. dev	0.05	0.03	0.08		10.41	0.09	0.06	0.05	0.02	0.02	0.03	0.12	0.06	0.05
3	mean	2.84	2.62	5.18	31.25	15.50	3.90	2.22	-3.22	0.66	1.12	2.06	5.09	3.12	2.90
	st. dev	0.87	0.17	2.29		9.26	0.96	2.01	3.18	0.61	1.06	2.01	4.76	2.95	2.82
4	mean	3.60	2.23	4.80		20.00	4.61	2.78	-4.98	0.91	1.54	3.06	7.04	4.30	4.30
	st. dev	1.71	0.32	2.17	31.25	10.80	1.63	3.11	5.30	1.05	1.68	3.27	8.12	4.69	4.60

ZM1HTDRV.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1 HTT		Driver		Z			Oct. 6/92					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
													RMS	RMQ	RMT
1	3	2.42	2.33	2.03	gravel	5	3.97	0.30	-0.37	0.08	0.12	0.20	0.65	0.33	0.29
2	1	2.45	2.20	2.41	gravel	10	4.23	0.33	-0.46	0.09	0.13	0.23	0.73	0.35	0.32
3	1	2.33	2.25	2.06	gravel	15	3.67	0.26	-0.36	0.08	0.11	0.20	0.65	0.32	0.28
4	1	2.29	2.26	1.91	gravel	20	3.61	0.22	-0.32	0.07	0.10	0.17	0.58	0.28	0.24
5	3	3.39	3.06	4.51	gravel	25	5.48	0.80	-0.75	0.14	0.25	0.48	1.10	0.70	0.67
6	4	20.34	0.66	1.91	gravel	30	24.71	15.79	-2.52	0.37	1.98	7.53	2.87	5.51	10.59
7	1	2.28	2.28	1.93	gravel	35	3.48	0.24	-0.34	0.08	0.11	0.19	0.65	0.32	0.27
8	1	2.44	2.23	2.99	paved	5	3.94	0.50	-0.40	0.11	0.16	0.28	0.89	0.44	0.39
9	1	2.18	2.22	3.76	paved	10	3.75	0.41	-0.51	0.12	0.16	0.27	0.95	0.46	0.38
10	2	1.90	2.10	3.88	paved	15	3.07	0.34	-0.40	0.12	0.15	0.23	0.93	0.43	0.32
11	1	2.20	2.20	3.13	paved	20	3.73	0.40	-0.40	0.11	0.14	0.24	0.83	0.40	0.33
12	2	2.07	2.15	6.27	paved	25	3.50	0.63	-0.60	0.18	0.23	0.36	1.36	0.64	0.51
17	1	2.09	2.16	2.75	secondary	5	3.55	0.36	-0.41	0.11	0.14	0.22	0.83	0.39	0.32
18	1	2.17	2.20	2.75	secondary	10	3.61	0.34	-0.39	0.10	0.13	0.22	0.78	0.37	0.31
19	1	2.19	2.22	2.95	secondary	15	3.47	0.33	-0.43	0.11	0.15	0.24	0.86	0.41	0.34
20	4	2.95	2.19	2.91	secondary	20	4.44	0.39	-0.70	0.12	0.17	0.36	0.95	0.48	0.51
21	4	3.80	2.14	3.62	secondary	25	5.40	0.77	-1.32	0.19	0.31	0.73	1.49	0.87	1.03
22	4	2.85	2.25	2.62	secondary	30	4.38	0.42	-0.72	0.13	0.18	0.37	1.00	0.51	0.52
23	4	2.99	2.45	2.40	secondary	35	4.25	0.40	-0.77	0.14	0.21	0.41	1.07	0.58	0.58
24	1	2.44	2.26	1.90	XC #3	5	4.14	0.42	-0.39	0.10	0.14	0.24	0.76	0.38	0.34
25	1	2.04	2.20	3.61	XC #3	5	3.43	0.60	-0.76	0.20	0.26	0.40	1.53	0.72	0.57
26	1	2.14	2.17	2.29	XC #3	10	3.68	0.54	-0.64	0.16	0.21	0.35	1.25	0.59	0.49
27	4	6.88	1.76	2.07	XC #3	15	12.12	3.80	-3.63	0.31	0.81	2.11	2.37	2.25	2.96
28	4	3.13	2.49	1.92	XC #4	5	5.19	1.52	-1.87	0.33	0.51	1.02	2.53	1.43	1.44
29	4	6.29	2.24	2.32	XC #4	10	10.54	1.95	-2.62	0.22	0.47	1.37	1.68	1.31	1.92
30	4	2.66	2.09	3.14	Churchville B	5	4.04	0.46	-0.79	0.15	0.21	0.41	1.20	0.58	0.58
31	1	2.34	2.19	2.12	Churchville B	10	3.85	0.44	-0.68	0.14	0.19	0.34	1.12	0.53	0.48
36	4	2.82	2.24	2.07	Churchville B	15	5.02	1.00	-1.09	0.21	0.30	0.59	1.62	0.84	0.83
37	4	10.83	1.56	2.09	Churchville B	20	17.88	22.33	-14.26	1.02	3.62	11.09	7.93	10.07	15.60
38	4	4.16	2.37	2.07	Churchville B	25	6.68	2.67	-2.08	0.36	0.65	1.48	2.75	1.81	2.08
39	4	4.63	2.19	2.35	Churchville B	30	7.73	3.54	-3.19	0.44	0.83	2.01	3.37	2.30	2.83
40	4	12.43	1.78	2.15	Churchville B	35	20.25	15.72	-8.75	0.60	2.02	7.51	4.68	5.63	10.56
SIGNAL TYPE					N % n										
1	mean	2.26	2.22	2.61	43.75	17.50	3.72	0.39	-0.46	0.11	0.15	0.26	0.89	0.43	0.36
	st. dev	0.13	0.04	0.62		5.24	0.24	0.11	0.13	0.03	0.04	0.07	0.26	0.12	0.09
2	mean	1.98	2.13	5.08	6.25	12.50	3.28	0.48	-0.50	0.15	0.19	0.30	1.15	0.53	0.42
	st. dev	0.12	0.03	1.69		11.73	0.30	0.21	0.14	0.04	0.05	0.10	0.30	0.15	0.13
3	mean	2.90	2.69	3.27	6.25	20.00	4.72	0.55	-0.56	0.11	0.19	0.34	0.87	0.52	0.48
	st. dev	0.68	0.52	1.75		9.44	1.06	0.35	0.27	0.04	0.10	0.19	0.31	0.27	0.27
4	mean	6.20	2.03	2.40	43.75	16.11	9.47	5.05	-3.16	0.33	0.88	2.64	2.54	2.44	3.72
	st. dev	5.10	0.48	0.50		11.12	6.80	7.23	3.82	0.24	1.00	3.44	1.88	2.77	4.83

M1026 HMMWV

XHMMVDRV.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Driver		X			Oct. 6/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
2	2	1.81	2.00	7.10	belgian block	25	2.78	1.87	-1.61	0.63	0.78	1.14	4.87	2.18	1.60
4	3	2.24	2.31	3.02	belgian block	35	3.62	1.86	-2.05	0.54	0.74	1.21	4.18	2.05	1.70
6	1	2.29	2.23	3.97	belgian block	45	3.47	3.13	-2.19	0.76	1.02	1.75	5.93	2.84	2.47
8	1	2.15	2.22	3.90	paved	35	3.51	0.31	-0.32	0.09	0.12	0.20	0.71	0.34	0.28
10	4	3.97	2.14	3.08	paved	45	5.79	0.39	-0.61	0.09	0.14	0.34	0.67	0.40	0.48
12	4	3.20	2.24	2.88	paved	55	5.12	0.47	-0.33	0.08	0.11	0.25	0.60	0.31	0.35
14	2	1.95	2.20	5.04	secondary-A	10	2.89	0.32	-0.26	0.10	0.13	0.19	0.77	0.36	0.27
16	2	1.96	2.20	3.57	secondary-A	20	2.86	0.43	-0.45	0.15	0.20	0.30	1.19	0.56	0.42
18	4	2.57	2.30	2.92	secondary-A	30	4.40	0.41	-0.38	0.09	0.13	0.23	0.70	0.35	0.33
19	3	2.10	2.39	4.94	X-Country #3	5	3.24	0.61	-0.54	0.18	0.24	0.37	1.38	0.68	0.52
20	4	2.51	2.52	5.40	X-Country #3	10	3.71	1.17	-1.09	0.30	0.45	0.76	2.35	1.27	1.07
21	3	2.64	2.61	4.92	X-Country #3	15	3.80	1.86	-2.38	0.56	0.84	1.47	4.32	2.35	2.07
SIGNAL TYPE					N % n										
1	mean	2.22	2.23	3.93	16.67	40.00	3.49	1.72	-1.26	0.43	0.57	0.97	3.32	1.59	1.37
	std. dev	0.10	0.01	0.05			0.02	1.99	1.32	0.48	0.64	1.10	3.69	1.77	1.55
2	mean	1.90	2.13	5.23	25.00	18.33	2.84	0.87	-0.77	0.29	0.37	0.54	2.27	1.03	0.76
	std. dev	0.08	0.11	1.77			0.06	0.87	0.73	0.29	0.36	0.52	2.25	1.00	0.73
3	mean	2.33	2.43	4.29	25.00	18.33	3.55	1.44	-1.66	0.43	0.61	1.02	3.29	1.69	1.43
	std. dev	0.28	0.15	1.10			0.29	0.72	0.98	0.21	0.32	0.57	1.66	0.89	0.81
4	mean	3.06	2.30	3.57	33.33	35.00	4.76	0.61	-0.60	0.14	0.21	0.40	1.08	0.58	0.56
	std. dev	0.68	0.16	1.22			0.90	0.37	0.35	0.11	0.16	0.25	0.85	0.46	0.35

YHMMVDRV.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Driver		Y			Oct. 6/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
2	2	2.30	2.18	4.94	belgian block	25	3.59	1.96	-1.94	0.54	0.75	1.25	4.21	2.08	1.76
4	2	1.94	2.14	3.88	belgian block	35	2.98	1.27	-1.35	0.44	0.57	0.85	3.42	1.59	1.20
6	2	2.23	2.27	5.06	belgian block	45	3.65	2.41	-2.21	0.63	0.86	1.41	4.91	2.39	1.99
8	2	2.20	2.20	5.22	paved	35	3.69	0.38	-0.37	0.10	0.14	0.22	0.79	0.38	0.32
10	4	3.77	2.13	3.04	paved	45	5.95	0.49	-0.64	0.10	0.15	0.36	0.74	0.42	0.50
12	4	2.92	2.29	4.92	paved	55	4.93	0.70	-0.73	0.14	0.22	0.42	1.12	0.61	0.59
14	2	2.09	2.20	4.23	secondary-A	10	2.69	0.37	-0.54	0.17	0.23	0.35	1.31	0.62	0.50
16	3	2.08	2.36	3.47	secondary-A	20	3.07	0.72	-0.72	0.23	0.32	0.49	1.82	0.88	0.69
18	1	2.34	2.20	3.46	secondary-A	30	3.99	0.54	-0.53	0.13	0.18	0.31	1.03	0.50	0.44
19	3	2.56	2.78	6.37	X-Country #3	5	3.92	0.87	-0.88	0.22	0.34	0.57	1.73	0.94	0.80
20	3	2.22	2.43	4.29	X-Country #3	10	3.27	1.05	-0.89	0.30	0.41	0.66	2.30	1.15	0.92
21	2	1.88	2.05	4.69	X-Country #3	15	2.83	1.51	-1.31	0.50	0.63	0.93	3.86	1.77	1.31
SIGNAL TYPE					N % n										
1	mean	2.34	2.20	3.46	8.33	30.00	3.99	0.54	-0.53	0.13	0.18	0.31	1.03	0.50	0.44
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2	mean	2.11	2.17	4.67	50.00	27.50	3.24	1.32	-1.29	0.40	0.53	0.84	3.08	1.47	1.18
	std. dev	0.17	0.07	0.52			0.46	0.83	0.73	0.21	0.29	0.47	1.66	0.80	0.67
3	mean	2.28	2.52	4.71	25.00	11.67	3.42	0.88	-0.83	0.25	0.36	0.57	1.95	0.99	0.80
	std. dev	0.25	0.22	1.49			0.44	0.17	0.09	0.04	0.05	0.08	0.30	0.14	0.12
4	mean	3.34	2.21	3.98	16.67	50.00	5.44	0.59	-0.68	0.12	0.18	0.39	0.93	0.51	0.55
	std. dev	0.60	0.11	1.33			0.72	0.15	0.06	0.04	0.05	0.05	0.27	0.14	0.06

ZHMMVDRV.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD		
M1026_HMMWV		Driver		Z			Oct. 6/92					British		
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)	
(run #)	TYPE					(mph)							RMS	RMQ	RMT
2	2	2.03	2.11	5.78	belgian block	25	3.06	6.92	-5.31	2.00	2.57	4.06	15.48	7.14	5.71
4	1	2.23	2.22	3.64	belgian block	35	3.37	7.24	-5.36	1.87	2.48	4.16	14.46	6.91	5.85
6	2	2.23	2.22	4.02	belgian block	45	3.62	7.92	-7.18	2.09	2.80	4.65	16.16	7.81	6.54
8	4	2.61	2.20	4.63	paved	35	4.14	1.58	-2.07	0.44	0.61	1.15	3.41	1.69	1.61
10	4	4.12	2.15	4.48	paved	45	6.28	2.49	-1.63	0.33	0.54	1.35	2.54	1.50	1.91
12	2	2.36	2.18	6.26	paved	55	3.86	1.47	-1.50	0.39	0.53	0.91	2.98	1.46	1.28
14	2	1.93	2.14	3.06	secondary-A	10	3.01	0.98	-1.03	0.33	0.43	0.65	2.58	1.20	0.91
16	4	2.50	2.19	3.81	secondary-A	20	3.76	1.61	-2.45	0.54	0.72	1.35	4.18	2.02	1.90
18	4	2.52	2.23	5.70	secondary-A	30	4.16	1.95	-1.83	0.45	0.64	1.15	3.52	1.78	1.61
19	4	2.56	2.34	3.21	X-Country #3	5	3.91	1.38	-1.09	0.32	0.45	0.81	2.45	1.26	1.14
20	4	3.89	2.34	3.13	X-Country #3	10	5.43	3.55	-1.96	0.51	0.85	1.97	3.93	2.36	2.78
21	4	3.39	2.30	3.48	X-Country #3	15	4.90	5.70	-3.68	0.96	1.51	3.25	7.41	4.21	4.57
SIGNAL TYPE					N % n										
1	mean	2.23	2.22	3.64	8.33	35.00	3.37	7.24	-5.36	1.87	2.48	4.16	14.46	6.91	5.85
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2	mean	2.14	2.16	4.78	33.33	33.75	3.38	4.32	-3.75	1.20	1.58	2.57	9.30	4.40	3.61
	std. dev	0.19	0.05	1.50			0.42	3.60	2.98	0.97	1.28	2.08	7.53	3.56	2.93
3	mean	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	3.09	2.25	4.06	58.33	22.86	4.65	2.61	-2.10	0.51	0.76	1.58	3.92	2.12	2.22
	std. dev	0.71	0.08	0.93			0.93	1.55	0.81	0.22	0.35	0.82	1.67	0.99	1.15

XHMMVCF.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Curb Front		X			Oct. 5/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
2	2	2.10	2.14	4.22	belgian block	25	3.14	0.95	-0.73	0.27	0.35	0.56	2.06	0.97	0.79
4	3	2.36	2.36	4.42	belgian block	35	3.88	1.38	-1.23	0.34	0.47	0.80	2.61	1.31	1.12
6	1	2.34	2.16	3.26	belgian block	45	3.87	1.51	-1.53	0.39	0.53	0.92	3.04	1.48	1.29
8	1	2.27	2.19	3.13	paved	35	3.74	0.18	-0.16	0.05	0.06	0.10	0.36	0.17	0.15
10	4	2.56	2.24	2.75	paved	45	4.23	0.22	-0.23	0.05	0.08	0.14	0.41	0.21	0.19
12	4	2.70	2.33	2.80	paved	55	4.30	0.24	-0.32	0.06	0.09	0.17	0.50	0.26	0.25
14	1	2.08	2.18	3.16	secondary-A	10	3.23	0.19	-0.15	0.05	0.07	0.11	0.41	0.19	0.15
16	4	2.54	2.15	2.59	secondary-A	20	4.37	0.36	-0.33	0.08	0.11	0.20	0.62	0.30	0.28
18	4	3.24	2.34	3.17	secondary-A	30	5.15	0.36	-0.25	0.06	0.09	0.19	0.46	0.24	0.27
19	3	2.10	2.33	3.23	X-Country #3	5	3.13	0.29	-0.30	0.09	0.13	0.20	0.73	0.36	0.28
20	4	2.63	2.43	3.33	X-Country #3	10	3.99	0.75	-0.61	0.17	0.25	0.45	1.32	0.70	0.63
21	3	2.23	2.44	5.19	X-Country #3	15	3.31	0.73	-0.85	0.24	0.33	0.53	1.85	0.93	0.75
SIGNAL TYPE					N % n										
1	mean	2.23	2.18	3.18	25.00	30.00	3.61	0.63	-0.61	0.16	0.22	0.38	1.27	0.61	0.53
	std. dev	0.13	0.01	0.07			0.34	0.76	0.79	0.20	0.27	0.47	1.53	0.75	0.66
2	mean	2.10	2.14	4.22	8.33	25.00	3.14	0.95	-0.73	0.27	0.35	0.56	2.06	0.97	0.79
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	mean	2.23	2.38	4.28	25.00	18.33	3.44	0.80	-0.79	0.22	0.31	0.51	1.73	0.86	0.72
	std. dev	0.13	0.06	0.99			0.39	0.55	0.47	0.12	0.17	0.30	0.95	0.48	0.42
4	mean	2.74	2.30	2.93	41.67	32.00	4.41	0.39	-0.35	0.09	0.12	0.23	0.66	0.34	0.32
	std. dev	0.29	0.11	0.31			0.44	0.22	0.15	0.05	0.07	0.12	0.38	0.20	0.18

YHMMVCF.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Curb Front		Y			Oct. 6/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
2	2	2.25	2.23	4.44	belgian block	25	3.60	1.45	-1.44	0.40	0.55	0.90	3.11	1.52	1.27
4	2	1.96	2.15	3.62	belgian block	35	3.06	0.97	-1.08	0.33	0.43	0.66	2.59	1.20	0.92
6	2	2.31	2.25	5.36	belgian block	45	3.75	1.85	-1.80	0.49	0.66	1.12	3.77	1.85	1.58
8	2	2.12	2.22	5.07	paved	35	3.36	0.26	-0.25	0.08	0.10	0.16	0.59	0.28	0.23
10	4	3.61	2.17	3.38	paved	45	5.22	0.27	-0.48	0.07	0.11	0.26	0.56	0.30	0.37
12	4	2.95	2.34	5.09	paved	55	4.72	0.45	-0.53	0.10	0.16	0.31	0.80	0.44	0.43
14	2	2.15	2.16	4.40	secondary-A	10	2.96	0.34	-0.47	0.14	0.18	0.29	1.06	0.50	0.41
16	3	2.13	2.44	3.82	secondary-A	20	3.09	0.54	-0.57	0.18	0.25	0.38	1.40	0.68	0.54
18	1	2.35	2.18	3.24	secondary-A	30	3.67	0.29	-0.43	0.10	0.13	0.23	0.76	0.37	0.32
19	3	2.46	2.56	5.69	X-Country #3	5	3.81	0.63	-0.61	0.16	0.24	0.40	1.27	0.66	0.57
20	3	2,29	2.40	4.27	X-Country #3	10	3.27	0.84	-0.69	0.24	0.33	0.54	1.82	0.92	0.76
21	2	1.87	2.16	4.33	X-Country #3	15	2.73	1.02	-1.09	0.39	0.50	0.72	3.00	1.38	1.02
SIGNAL TYPE					N % n										
1	mean	2.35	2.18	3.24	8.33	30.00	3.67	0.29	-0.43	0.10	0.13	0.23	0.76	0.37	0.32
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2	mean	2.11	2.20	4.54	50.00	27.50	3.24	0.98	-1.02	0.30	0.40	0.64	2.35	1.12	0.90
	std. dev	0.17	0.04	0.61			0.39	0.62	0.58	0.16	0.22	0.36	1.25	0.61	0.51
3	mean	2.29	2.47	4.59	25.00	11.67	3.39	0.67	-0.63	0.19	0.27	0.44	1.50	0.76	0.62
	std. dev	0.16	0.09	0.98			0.38	0.15	0.06	0.04	0.05	0.08	0.29	0.15	0.12
4	mean	3.28	2.26	4.23	16.67	50.00	4.97	0.36	-0.51	0.09	0.13	0.28	0.68	0.37	0.40
	std. dev	0.47	0.12	1.21			0.35	0.12	0.03	0.02	0.04	0.03	0.17	0.10	0.04

ZHMMVCF.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Curb Front		Z			Feb. 17/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
2	2	1.92	2.19	4.40	belgian block	25	3.01	4.39	-4.73	1.52	1.96	2.91	11.74	5.46	4.10
4	2	2.26	2.17	4.17	belgian block	35	3.70	7.34	-6.60	1.89	2.53	4.25	14.61	7.03	5.98
6	3	2.44	2.30	3.74	belgian block	45	3.96	9.49	-10.82	2.56	3.56	6.25	19.86	9.90	8.79
8	2	2.40	2.15	5.28	paved	35	3.98	1.50	-1.61	0.39	0.53	0.93	3.02	1.46	1.32
10	4	3.48	2.15	4.14	paved	45	6.07	1.87	-2.17	0.33	0.50	1.16	2.58	1.40	1.63
12	4	3.65	2.21	5.05	paved	55	6.01	3.47	-2.64	0.51	0.80	1.85	3.94	2.24	2.61
14	1	2.24	2.21	3.45	secondary-A	10	3.88	1.09	-1.17	0.29	0.39	0.65	2.26	1.08	0.92
16	4	2.82	2.38	4.62	secondary-A	20	4.80	1.84	-2.02	0.40	0.59	1.14	3.12	1.65	1.60
18	4	3.05	2.31	3.76	secondary-A	30	4.91	2.40	-1.94	0.44	0.69	1.35	3.43	1.91	1.90
19	4	3.51	2.13	2.75	X-Country #3	5	4.92	2.16	-1.18	0.34	0.54	1.19	2.63	1.51	1.68
20	4	5.87	2.25	2.73	X-Country #3	10	8.29	5.70	-3.17	0.53	1.19	3.14	4.14	3.31	4.42
21	4	3.13	2.29	2.67	X-Country #3	15	5.07	3.13	-3.67	0.67	1.02	2.10	5.19	2.84	2.95
SIGNAL TYPE					N % n										
1	mean	2.82	2.38	4.62	8.33	20.00	4.80	1.84	-2.02	0.40	0.59	1.14	3.12	1.65	1.60
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2	mean	2.19	2.17	4.62	25.00	31.67	3.56	4.41	-4.31	1.26	1.67	2.70	9.79	4.65	3.80
	std. dev	0.24	0.02	0.59			0.50	2.92	2.52	0.78	1.03	1.67	6.04	2.87	2.35
3	mean	2.44	2.30	3.74	8.33	45.00	3.96	9.49	-10.82	2.56	3.56	6.25	19.86	9.90	8.79
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	3.64	2.25	3.67	58.33	25.71	5.73	2.94	-2.40	0.46	0.76	1.70	3.57	2.12	2.40
	std. dev	1.02	0.09	0.98			1.25	1.36	0.83	0.12	0.26	0.74	0.93	0.72	1.03

XHMMVCR.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Curb Rear		X			Oct. 6/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
2	2	1.93	2.10	4.42	belgian block	25	3.02	0.95	-0.86	0.30	0.39	0.58	2.33	1.07	0.82
4	3	2.23	2.31	3.06	belgian block	35	3.65	1.45	-1.36	0.39	0.53	0.86	2.99	1.47	1.21
6	2	1.94	2.12	3.25	belgian block	45	2.92	1.42	-1.43	0.49	0.63	0.94	3.77	1.76	1.33
8	4	2.71	2.21	3.86	paved	35	4.20	0.21	-0.27	0.06	0.08	0.15	0.44	0.22	0.22
10	4	2.71	2.26	2.58	paved	45	4.53	0.29	-0.32	0.07	0.10	0.19	0.53	0.27	0.26
12	1	2.35	2.29	3.97	paved	55	3.89	0.32	-0.37	0.09	0.12	0.21	0.69	0.34	0.30
14	4	3.89	2.25	3.35	secondary-A	10	4.67	0.48	-1.31	0.19	0.33	0.75	1.48	0.94	1.05
16	1	2.10	2.25	3.82	secondary-A	20	3.32	0.33	-0.34	0.10	0.14	0.21	0.78	0.38	0.30
18	3	2.45	2.31	2.37	secondary-A	30	4.01	0.36	-0.38	0.09	0.13	0.22	0.71	0.36	0.32
19	3	2.36	2.30	3.45	X-Country #3	5	3.39	0.47	-0.32	0.12	0.16	0.27	0.90	0.45	0.39
20	1	2.17	2.27	3.86	X-Country #3	10	3.23	1.15	-1.15	0.36	0.49	0.77	2.76	1.36	1.09
21	3	2.69	2.74	5.34	X-Country #3	15	3.56	0.92	-1.32	0.31	0.48	0.85	2.44	1.33	1.19
SIGNAL TYPE					N % n										
1	mean	2.21	2.27	3.88	25.00	28.33	3.48	0.60	-0.62	0.18	0.25	0.40	1.41	0.69	0.56
	std. dev	0.13	0.02	0.08			0.36	0.48	0.46	0.15	0.21	0.32	1.17	0.58	0.46
2	mean	1.93	2.11	3.84	16.67	35.00	2.97	1.18	-1.14	0.39	0.51	0.76	3.05	1.41	1.07
	std. dev	0.00	0.01	0.82			0.07	0.33	0.40	0.13	0.17	0.26	1.02	0.49	0.36
3	mean	2.43	2.42	3.55	33.33	21.25	3.65	0.80	-0.84	0.23	0.32	0.55	1.76	0.90	0.78
	std. dev	0.20	0.22	1.27			0.26	0.50	0.57	0.15	0.21	0.35	1.13	0.58	0.49
4	mean	3.11	2.24	3.26	25.00	30.00	4.47	0.33	-0.63	0.11	0.17	0.36	0.82	0.48	0.51
	std. dev	0.68	0.03	0.64			0.24	0.14	0.58	0.07	0.14	0.33	0.58	0.40	0.47

YHMMVCR.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Curb Rear		Y			Oct. 6/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
2	3	2.33	2.39	3.23	belgian block	25	3.45	1.59	-1.30	0.42	0.59	0.98	3.25	1.63	1.37
4	1	2.05	2.10	3.26	belgian block	35	3.01	1.11	-1.56	0.44	0.58	0.91	3.44	1.60	1.28
6	1	2.06	2.27	3.28	belgian block	45	3.12	1.67	-1.95	0.58	0.78	1.20	4.50	2.17	1.68
8	3	2.13	2.38	3.66	paved	35	3.33	0.36	-0.30	0.10	0.14	0.21	0.77	0.38	0.30
10	4	2.89	2.26	2.62	paved	45	4.60	0.36	-0.47	0.09	0.13	0.26	0.70	0.37	0.37
12	4	2.77	2.23	4.36	paved	55	4.63	0.44	-0.55	0.11	0.15	0.29	0.82	0.42	0.41
14	4	2.65	2.36	4.36	secondary-A	10	3.10	0.42	-0.84	0.20	0.30	0.54	1.57	0.83	0.76
16	1	2.00	2.23	3.83	secondary-A	20	2.98	0.64	-0.70	0.23	0.30	0.45	1.75	0.82	0.64
18	1	2.24	2.27	2.94	secondary-A	30	3.33	0.49	-0.39	0.13	0.18	0.30	1.02	0.51	0.42
19	3	2.69	2.69	6.73	X-Country #3	5	3.73	0.98	-0.71	0.23	0.34	0.61	1.76	0.95	0.86
20	2	1.86	2.23	4.46	X-Country #3	10	2.65	0.92	-0.86	0.34	0.43	0.63	2.60	1.20	0.88
21	2	1.93	2.15	4.68	X-Country #3	15	2.55	1.21	-1.53	0.54	0.69	1.04	4.16	1.94	1.46
SIGNAL TYPE					N % n										
1	mean	2.09	2.22	3.33	33.33	32.50	3.11	0.98	-1.15	0.35	0.46	0.71	2.68	1.27	1.00
	std. dev	0.11	0.08	0.37			0.16	0.53	0.73	0.20	0.27	0.41	1.58	0.75	0.58
2	mean	1.89	2.19	4.57	16.67	12.50	2.60	1.07	-1.20	0.44	0.56	0.83	3.38	1.57	1.17
	std. dev	0.05	0.05	0.15			0.07	0.20	0.47	0.14	0.18	0.29	1.10	0.52	0.41
3	mean	2.38	2.49	4.54	25.00	21.67	3.50	0.98	-0.77	0.25	0.36	0.60	1.93	0.99	0.84
	std. dev	0.28	0.18	1.91			0.21	0.61	0.50	0.16	0.23	0.38	1.25	0.63	0.54
4	mean	2.77	2.28	3.78	25.00	36.67	4.11	0.41	-0.62	0.13	0.19	0.36	1.03	0.54	0.51
	std. dev	0.12	0.07	1.00			0.88	0.04	0.19	0.06	0.09	0.15	0.47	0.25	0.21

ZHMMVCR.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Curb Rear		Z			Oct. 6/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
2	1	2.04	2.18	3.23	belgian block	25	3.28	6.01	-5.96	1.83	2.39	3.72	14.14	6.66	5.23
4	1	2.26	2.22	3.36	belgian block	35	3.58	6.05	-5.26	1.58	2.13	3.56	12.23	5.94	5.01
6	1	2.23	2.29	3.86	belgian block	45	3.59	8.98	-7.88	2.35	3.20	5.23	18.18	8.92	7.35
8	4	2.52	2.34	3.18	paved	35	4.31	1.11	-1.17	0.26	0.37	0.67	2.05	1.04	0.94
10	4	3.64	2.39	3.08	paved	45	5.79	2.11	-1.55	0.32	0.51	1.15	2.45	1.41	1.62
12	4	3.57	2.31	4.82	paved	55	5.56	2.92	-4.53	0.67	1.07	2.40	5.20	2.97	3.37
14	4	2.91	2.16	3.42	secondary-A	10	5.14	1.21	-1.30	0.24	0.34	0.71	1.89	0.95	1.00
16	4	2.58	2.24	3.86	secondary-A	20	3.82	1.26	-1.86	0.41	0.57	1.06	3.17	1.57	1.49
18	4	3.59	2.43	4.07	secondary-A	30	5.98	3.59	-3.23	0.57	0.98	2.04	4.41	2.74	2.88
19	4	2.55	2.33	3.36	X-Country #3	5	3.65	1.10	-0.66	0.24	0.34	0.61	1.87	0.93	0.86
20	4	4.08	2.45	2.69	X-Country #3	10	6.16	3.30	-2.30	0.45	0.81	1.85	3.52	2.27	2.61
21	3	2.34	2.36	3.29	X-Country #3	15	3.49	2.43	-2.03	0.64	0.89	1.49	4.95	2.49	2.10
SIGNAL TYPE					N % n										
1	mean	2.17	2.23	3.48	25.00	35.00	3.48	7.02	-6.37	1.92	2.58	4.17	14.85	7.17	5.86
	std. dev	0.12	0.06	0.33			0.18	1.70	1.36	0.39	0.56	0.92	3.04	1.56	1.29
2	mean	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	mean	2.34	2.36	3.29	8.33	15.00	3.49	2.43	-2.03	0.64	0.89	1.49	4.95	2.49	2.10
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	3.18	2.33	3.56	66.67	26.25	5.05	2.08	-2.08	0.40	0.62	1.31	3.07	1.73	1.84
	std. dev	0.61	0.10	0.67			1.00	1.06	1.26	0.16	0.29	0.69	1.24	0.82	0.97

XHMMVRR.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Road Rear		X			Oct. 6/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
2	2	1.93	2.04	5.42	belgian block	25	2.97	0.71	-0.78	0.25	0.32	0.48	1.95	0.89	0.68
4	1	2.21	2.25	3.47	belgian block	35	3.55	1.15	-1.03	0.31	0.41	0.68	2.38	1.15	0.96
6	1	2.07	2.22	3.94	belgian block	45	3.23	1.34	-1.18	0.39	0.52	0.81	3.02	1.45	1.13
8	2	2.16	2.15	5.00	paved	35	3.46	0.19	-0.19	0.05	0.07	0.12	0.42	0.20	0.17
10	1	2.08	2.16	3.78	paved	45	3.37	0.19	-0.16	0.05	0.07	0.11	0.40	0.19	0.15
12	2	2.11	2.24	4.30	paved	55	3.36	0.25	-0.25	0.07	0.10	0.16	0.57	0.27	0.22
14	2	1.95	2.21	4.77	secondary-A	10	3.06	0.15	-0.16	0.05	0.07	0.10	0.39	0.18	0.14
16	1	2.30	2.22	3.53	secondary-A	20	3.70	0.24	-0.31	0.07	0.10	0.17	0.57	0.27	0.24
18	4	2.97	2.23	3.11	secondary-A	30	4.53	0.34	-0.22	0.06	0.09	0.18	0.47	0.24	0.26
19	3	2.32	2.61	3.85	X-Country #3	5	3.30	0.32	-0.38	0.11	0.15	0.25	0.82	0.43	0.35
20	4	2.82	2.51	3.78	X-Country #3	10	4.31	0.80	-0.76	0.18	0.28	0.51	1.40	0.79	0.71
21	3	2.42	2.79	7.57	X-Country #3	15	3.12	0.93	-1.26	0.35	0.52	0.85	2.72	1.44	1.20
SIGNAL TYPE					N % n										
1	mean	2.16	2.21	3.68	33.33	36.25	3.46	0.73	-0.67	0.21	0.28	0.44	1.59	0.77	0.62
	std. dev	0.11	0.04	0.22			0.20	0.60	0.51	0.17	0.23	0.35	1.31	0.63	0.50
2	mean	2.03	2.16	4.87	33.33	31.25	3.21	0.33	-0.34	0.11	0.14	0.21	0.83	0.39	0.30
	std. dev	0.11	0.08	0.47			0.23	0.26	0.29	0.10	0.12	0.18	0.75	0.34	0.26
3	mean	2.37	2.70	5.71	16.67	10.00	3.21	0.63	-0.82	0.23	0.34	0.55	1.77	0.94	0.77
	std. dev	0.07	0.13	2.63			0.13	0.43	0.63	0.17	0.26	0.43	1.35	0.71	0.60
4	mean	2.89	2.37	3.44	16.67	20.00	4.42	0.57	-0.49	0.12	0.19	0.34	0.94	0.52	0.49
	std. dev	0.11	0.20	0.47			0.15	0.32	0.38	0.08	0.14	0.23	0.65	0.39	0.32

YHMMVRR.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Road Rear		Y			Oct. 6/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
2	3	2.46	2.48	3.26	belgian block	25	3.65	1.22	-1.07	0.31	0.45	0.77	2.42	1.24	1.08
4	2	1.99	2.15	3.77	belgian block	35	2.93	0.75	-0.96	0.29	0.38	0.58	2.26	1.06	0.82
6	1	2.14	2.26	3.39	belgian block	45	3.20	1.09	-1.39	0.39	0.52	0.83	3.01	1.46	1.17
8	3	2.13	2.37	3.48	paved	35	3.20	0.21	-0.20	0.06	0.09	0.13	0.49	0.24	0.19
10	4	2.69	2.27	2.49	paved	45	4.37	0.22	-0.27	0.06	0.08	0.15	0.43	0.22	0.21
12	4	2.90	2.24	3.78	paved	55	4.81	0.29	-0.36	0.07	0.10	0.20	0.52	0.27	0.27
14	2	2.20	2.29	4.18	secondary-A	10	2.84	0.31	-0.43	0.13	0.18	0.29	1.01	0.49	0.40
16	2	2.04	2.26	5.03	secondary-A	20	2.86	0.43	-0.53	0.17	0.22	0.34	1.30	0.61	0.48
18	2	1.99	2.09	3.06	secondary-A	30	3.25	0.24	-0.27	0.08	0.10	0.16	0.61	0.28	0.22
19	3	2.59	2.88	7.12	X-Country #3	5	3.55	0.76	-0.58	0.19	0.29	0.49	1.46	0.80	0.69
20	3	2.16	2.50	5.01	X-Country #3	10	3.14	0.67	-0.73	0.22	0.31	0.48	1.73	0.87	0.68
21	2	1.92	2.24	5.30	X-Country #3	15	2.57	0.91	-1.10	0.39	0.51	0.75	3.03	1.42	1.06
SIGNAL TYPE					N % n										
1	mean	2.14	2.26	3.39	8.33	45.00	3.20	1.09	-1.39	0.39	0.52	0.83	3.01	1.46	1.17
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2	mean	2.03	2.20	4.27	41.67	22.00	2.89	0.53	-0.66	0.21	0.28	0.42	1.64	0.77	0.60
	std. dev	0.10	0.08	0.92			0.24	0.29	0.36	0.13	0.16	0.24	0.99	0.46	0.34
3	mean	2.33	2.56	4.72	33.33	18.75	3.39	0.71	-0.64	0.20	0.28	0.47	1.52	0.79	0.66
	std. dev	0.23	0.22	1.78			0.25	0.41	0.36	0.10	0.15	0.26	0.80	0.41	0.37
4	mean	2.80	2.25	3.13	16.67	50.00	4.59	0.25	-0.31	0.06	0.09	0.17	0.48	0.25	0.24
	std. dev	0.15	0.02	0.92			0.31	0.05	0.06	0.01	0.01	0.03	0.06	0.04	0.04

ZHMMVRR.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Road Rear		Z			Oct. 6/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
2	2	2.01	2.19	4.06	belgian block	25	3.09	6.54	-6.37	2.09	2.74	4.20	16.17	7.64	5.90
4	1	2.44	2.17	3.74	belgian block	35	4.04	10.39	-10.01	2.53	3.49	6.17	19.57	9.73	8.69
6	2	2.48	2.26	4.46	belgian block	45	3.88	13.47	-17.52	4.00	5.50	9.91	30.95	15.30	13.94
8	4	2.55	2.24	6.90	paved	35	4.30	2.34	-2.46	0.56	0.78	1.42	4.32	2.17	2.00
10	4	2.98	2.17	4.78	paved	45	4.81	1.65	-2.07	0.39	0.57	1.15	2.99	1.59	1.62
12	4	3.92	2.36	6.33	paved	55	6.28	4.98	-3.90	0.71	1.23	2.77	5.48	3.42	3.90
14	4	2.90	2.10	3.58	secondary-A	10	4.14	1.99	-1.23	0.39	0.54	1.12	3.01	1.50	1.58
16	4	3.05	2.20	3.13	secondary-A	20	5.12	2.51	-2.81	0.52	0.77	1.58	4.02	2.13	2.22
18	4	3.50	2.39	4.69	secondary-A	30	5.06	2.18	-3.60	0.57	0.91	1.99	4.42	2.52	2.81
19	4	4.35	2.07	3.01	X-Country #3	5	5.55	3.06	-1.43	0.40	0.72	1.76	3.13	2.02	2.47
20	4	5.51	2.45	3.29	X-Country #3	10	6.58	7.19	-2.40	0.73	1.56	4.02	5.65	4.36	5.65
21	3	2.26	2.31	3.63	X-Country #3	15	3.37	3.34	-2.73	0.90	1.23	2.04	6.97	3.44	2.86
SIGNAL TYPE					N % n										
1	mean	2.44	2.17	3.74	8.33	35.00	4.04	10.39	-10.01	2.53	3.49	6.17	19.57	9.73	8.69
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2	mean	2.24	2.23	4.26	16.67	35.00	3.48	10.01	-11.94	3.04	4.12	7.05	23.56	11.47	9.92
	std. dev	0.33	0.05	0.28			0.56	4.90	7.89	1.35	1.95	4.04	10.45	5.42	5.69
3	mean	2.26	2.31	3.63	8.33	15.00	3.37	3.34	-2.73	0.90	1.23	2.04	6.97	3.44	2.86
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	3.59	2.25	4.46	66.67	26.25	5.23	3.24	-2.49	0.53	0.88	1.98	4.13	2.46	2.78
	std. dev	0.97	0.14	1.49			0.87	1.90	0.94	0.14	0.35	0.98	1.06	0.97	1.38

M109A3

XM109CHF.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M109A3		Chief		X			Feb. 16/93					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE	(mph)							RMS	RMQ	RMT
7	2	1.895	2.312	5.555	profile IV north	5	2.696	1.961	-2.197	0.771	1.012	1.462	5.975	2.815	2.056
8	3	2.187	2.384	5.589	profile IV south	5	3.210	3.365	-2.874	0.972	1.344	2.125	7.529	3.732	2.990
9	3	2.168	2.436	7.177	profile IV north	10	3.284	4.610	-4.769	1.428	1.979	3.096	11.060	5.506	4.354
10	3	2.009	2.346	7.318	profile IV south	10	2.810	6.189	-5.175	2.022	2.756	4.063	15.660	7.670	5.715
13	2	1.889	2.024	4.268	6" WB	5	2.785	1.982	-2.464	0.798	1.023	1.508	6.184	2.848	2.121
14	1	2.128	2.155	3.774	6" WB	10	3.708	1.240	-1.338	0.348	0.457	0.740	2.694	1.272	1.041
15	2	1.972	2.156	3.638	paved	6	3.178	0.420	-0.458	0.138	0.179	0.272	1.069	0.498	0.383
18	1	2.088	2.138	3.500	paved	8	3.452	0.464	-0.374	0.121	0.159	0.254	0.941	0.442	0.357
19	1	2.273	2.197	3.976	paved	10	3.572	0.623	-0.742	0.191	0.258	0.434	1.479	0.718	0.611
20	2	2.210	2.162	5.221	paved	12	3.941	0.845	-0.762	0.204	0.269	0.451	1.579	0.748	0.634
21	2	1.917	2.085	3.867	paved	14	3.071	0.720	-0.636	0.221	0.281	0.423	1.709	0.783	0.595
22	2	2.169	2.262	4.202	paved	16	3.647	0.680	-0.720	0.192	0.258	0.416	1.486	0.719	0.585
23	1	2.054	2.157	3.908	paved	18	3.452	0.710	-0.705	0.205	0.267	0.421	1.587	0.744	0.592
25	1	2.124	2.134	3.313	paved	20	3.486	0.673	-0.802	0.212	0.276	0.450	1.639	0.766	0.632
26	4	2.589	2.186	3.533	paved	22	4.682	0.915	-1.079	0.213	0.288	0.551	1.649	0.802	0.775
27	1	2.139	2.141	3.721	paved	24	3.493	0.650	-0.788	0.206	0.270	0.440	1.594	0.751	0.619
28	1	2.116	2.164	2.629		26	3.417	0.575	-0.514	0.159	0.210	0.337	1.234	0.585	0.474
29	1	2.105	2.289	3.915	XC #3	5	2.918	0.979	-0.729	0.293	0.397	0.616	2.268	1.105	0.867
30	3	2.992	2.766	6.640	XC #3	10	4.426	4.979	-4.271	1.045	1.727	3.126	8.094	4.806	4.398
SIGNAL TYPE					N % n										
1	mean	2.13	2.17	3.59	42.11	15.13	3.44	0.74	-0.75	0.22	0.29	0.46	1.68	0.80	0.65
	std. dev	0.06	0.05	0.45			0.23	0.25	0.28	0.07	0.10	0.15	0.56	0.27	0.21
2	mean	2.01	2.17	4.46	31.58	9.67	3.22	1.10	-1.21	0.39	0.50	0.76	3.00	1.40	1.06
	std. dev	0.14	0.11	0.76			0.49	0.69	0.88	0.31	0.40	0.57	2.40	1.11	0.80
3	mean	2.34	2.48	6.68	21.05	8.75	3.43	4.79	-4.27	1.37	1.95	3.10	10.59	5.43	4.36
	std. dev	0.44	0.19	0.78			0.69	1.16	1.00	0.48	0.60	0.79	3.72	1.66	1.11
4	mean	2.59	2.19	3.53	5.30	22.00	4.68	0.91	-1.08	0.21	0.29	0.55	1.65	0.80	0.78
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

YM109CHF.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M109A3		Chief		Y			Feb. 16/93					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE	(mph)							RMS	RMQ	RMT
7	2	2.466	2.242	4.226	profile IV north	5	4.174	1.567	-1.654	0.386	0.539	0.951	2.988	1.501	1.338
8	3	2.282	2.400	3.128	profile IV south	5	3.477	1.525	-1.866	0.488	0.679	1.113	3.777	1.891	1.565
9	4	2.952	2.455	4.749	profile IV north	10	4.288	2.974	-4.651	0.889	1.374	2.624	6.886	3.825	3.691
10	4	2.508	2.224	3.007	profile IV south	10	4.236	2.452	-3.598	0.714	0.968	1.791	5.532	2.696	2.520
13	4	2.623	2.132	2.965	6" WB	5	4.154	1.915	-1.450	0.405	0.563	1.062	3.138	1.567	1.495
14	1	2.467	2.220	3.894	6" WB	10	3.948	0.897	-1.152	0.260	0.359	0.640	2.010	0.998	0.901
15	1	2.088	2.198	2.497	paved	6	3.187	0.150	-0.200	0.055	0.072	0.115	0.426	0.202	0.161
18	1	2.205	2.134	3.256	paved	8	3.666	0.333	-0.422	0.103	0.135	0.227	0.798	0.376	0.319
19	2	1.985	2.083	4.365	paved	10	3.421	0.548	-0.507	0.154	0.198	0.306	1.195	0.550	0.431
20	2	2.016	2.162	5.392	paved	12	3.364	0.725	-0.721	0.215	0.280	0.433	1.665	0.779	0.610
21	2	2.082	2.177	4.570	paved	14	3.421	0.767	-0.692	0.213	0.280	0.444	1.651	0.778	0.624
22	2	2.338	2.259	4.140	paved	16	4.037	0.763	-0.902	0.206	0.282	0.482	1.597	0.785	0.678
23	2	2.051	2.203	4.261	paved	18	3.369	0.868	-0.853	0.256	0.337	0.524	1.979	0.940	0.737
25	2	1.827	2.052	5.908	paved	20	2.886	1.410	-1.412	0.489	0.616	0.893	3.787	1.713	1.256
26	1	2.081	2.195	3.996	paved	22	3.541	1.163	-1.026	0.309	0.407	0.643	2.395	1.133	0.905
27	1	2.099	2.148	3.575	paved	24	3.461	1.075	-0.934	0.290	0.381	0.609	2.248	1.059	0.857
28	1	2.007	2.127	3.729		26	3.374	0.827	-0.757	0.235	0.303	0.471	1.818	0.843	0.663
29	3	2.085	2.305	3.670	XC #3	5	3.303	0.569	-0.596	0.176	0.237	0.368	1.365	0.660	0.517
30	3	2.785	2.706	4.920	XC #3	10	4.112	2.560	-2.935	0.668	1.061	1.861	5.175	2.955	2.617
SIGNAL TYPE					N % n										
1	mean	2.16	2.17	3.49	31.58	16.00	3.53	0.74	-0.75	0.21	0.28	0.45	1.62	0.77	0.63
	std. dev	0.16	0.04	0.55			0.26	0.41	0.37	0.10	0.14	0.23	0.81	0.39	0.32
2	mean	2.11	2.17	4.69	36.84	13.57	3.52	0.95	-0.96	0.27	0.36	0.58	2.12	1.01	0.81
	std. dev	0.22	0.08	0.68			0.44	0.38	0.42	0.12	0.15	0.25	0.92	0.43	0.35
3	mean	2.38	2.47	3.91	15.79	6.67	3.63	1.55	-1.80	0.44	0.66	1.11	3.44	1.84	1.57
	std. dev	0.36	0.21	0.92			0.43	1.00	1.17	0.25	0.41	0.75	1.93	1.15	1.05
4	mean	2.69	2.27	3.57	15.79	8.33	4.23	2.45	-3.23	0.67	0.97	1.83	5.19	2.70	2.57
	std. dev	0.23	0.17	1.02			0.07	0.53	1.63	0.25	0.41	0.78	1.90	1.13	1.10

ZM109CHF.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M109A3		Chief		Z			Feb. 16/93					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
7	4	2.707	2.312	3.034	profile IV north	5	4.619	5.872	-5.429	1.223	1.784	3.312	9.476	4.965	4.659
8	3	2.388	2.576	3.068	profile IV south	5	3.793	8.822	-9.733	2.446	3.588	5.842	18.950	9.987	8.217
9	4	2.769	2.494	2.623	profile IV north	10	4.258	14.890	-10.460	2.977	4.452	8.242	23.060	12.390	11.590
10	4	3.977	2.335	2.465	profile IV south	10	6.072	26.470	-14.490	3.372	5.372	13.410	26.120	14.950	18.870
13	2	2.334	1.873	4.806	6" WB	5	3.469	29.910	-15.460	6.540	8.063	15.270	50.660	22.420	21.480
14	2	1.937	2.123	4.730	6" WB	10	3.318	19.240	-16.530	5.390	6.910	10.440	41.750	19.230	14.690
15	2	1.878	2.113	6.727	paved	6	2.940	5.835	-5.226	1.881	2.419	3.533	14.570	6.734	4.970
18	1	2.060	2.096	3.581	paved	8	3.505	3.620	-2.960	0.939	1.210	1.934	7.271	3.368	2.720
19	2	1.627	1.842	9.002	paved	10	2.437	9.815	-7.707	3.594	4.264	5.848	27.840	11.870	8.226
20	2	1.640	1.822	10.830	paved	12	2.640	11.020	-9.187	3.829	4.533	6.281	29.660	12.620	8.835
21	2	1.591	1.783	8.106	paved	14	2.608	11.770	-9.146	4.011	4.703	6.382	31.070	13.090	8.977
22	2	1.769	1.938	9.418	paved	16	2.940	10.940	-10.730	3.686	4.516	6.522	28.550	12.570	9.175
23	2	2.187	2.115	4.856	paved	18	3.660	9.976	-7.955	2.450	3.191	5.357	18.970	8.882	7.536
25	2	2.226	2.173	4.229	paved	20	3.664	6.576	-5.721	1.678	2.237	3.735	13.000	6.227	5.253
26	2	2.104	2.170	4.837	paved	22	3.640	7.624	-7.014	2.011	2.646	4.230	15.570	7.366	5.950
27	2	2.387	2.147	5.567	paved	24	3.918	9.697	-6.569	2.076	2.709	4.954	16.080	7.541	6.969
28	2	2.056	2.213	5.836		26	3.386	8.553	-7.727	2.404	3.165	4.943	18.620	8.809	6.952
29	2	1.913	2.120	3.971	XC #3	5	3.103	4.189	-3.376	1.219	1.561	2.331	9.441	4.345	3.279
30	4	3.260	2.130	3.808	XC #3	10	4.777	14.840	-9.459	2.543	3.724	8.289	19.700	10.360	11.660
SIGNAL TYPE					N % n										
1	mean	2.06	2.10	3.58	5.26	8.00	3.51	3.62	-2.96	0.94	1.21	1.93	7.27	3.37	2.72
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2	mean	1.97	2.03	6.38	68.42	14.46	3.21	11.17	-8.64	3.14	3.92	6.14	24.29	10.90	8.64
	std. dev	0.27	0.16	2.24			0.47	6.71	3.77	1.56	1.88	3.37	12.08	5.23	4.74
3	mean	2.39	2.58	3.07	5.26	5.00	3.79	8.82	-9.73	2.45	3.59	5.84	18.95	9.99	8.22
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	3.18	2.32	2.98	21.05	8.75	4.93	15.52	-9.96	2.53	3.83	8.31	19.59	10.67	11.69
	std. dev	0.59	0.15	0.60			0.79	8.44	3.72	0.93	1.52	4.12	7.23	4.24	5.80

XM109DRV.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M109A3		Driver		X			Oct 1/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE	(mph)							RMS	RMQ	RMT
7	1	2.26	2.29	3.70	profile IV south	5	3.48	1.56	-1.37	0.42	0.58	0.95	3.27	1.61	1.34
8	3	2.78	2.68	6.59	profile IV south	5	4.32	3.56	-3.24	0.79	1.22	2.18	6.09	3.40	3.07
9	4	2.74	2.47	4.00	profile IV north	10	4.00	2.51	-3.30	0.73	1.08	1.99	5.62	3.01	2.80
10	3	2.42	2.32	3.27	profile IV south	10	3.44	2.58	-1.68	0.62	0.86	1.50	4.80	2.40	2.11
13	2	1.96	2.18	4.62	6' WB	5	3.06	2.00	-2.09	0.67	0.88	1.31	5.19	2.46	1.85
14	2	1.54	1.77	7.73	6' WB	10	2.25	1.63	-1.40	0.67	0.79	1.04	5.22	2.21	1.46
15	2	1.77	2.03	5.30	paved	6	2.82	0.50	-0.53	0.18	0.23	0.32	1.41	0.63	0.45
18	2	1.87	2.07	5.29	paved	8	3.10	0.56	-0.54	0.18	0.22	0.33	1.37	0.62	0.46
19	4	2.68	2.24	3.06	paved	10	4.48	0.66	-0.77	0.16	0.23	0.43	1.24	0.63	0.60
20	1	2.33	2.23	2.15	paved	12	3.85	0.53	-0.51	0.13	0.18	0.31	1.04	0.51	0.44
21	1	2.08	2.19	3.10	paved	14	3.42	0.65	-0.51	0.17	0.22	0.35	1.31	0.62	0.49
22	2	2.14	2.24	5.35	paved	16	3.70	0.82	-0.83	0.22	0.30	0.48	1.73	0.84	0.67
23	4	2.67	2.41	2.31	paved	18	4.15	0.54	-0.63	0.14	0.21	0.38	1.10	0.58	0.53
25	1	2.21	2.26	2.56	paved	20	3.64	0.46	-0.52	0.13	0.18	0.30	1.04	0.51	0.42
26	1	2.03	2.17	2.20	paved	22	3.40	0.43	-0.45	0.13	0.17	0.26	1.01	0.47	0.37
27	1	2.14	2.28	1.89	paved	24	3.58	0.44	-0.40	0.12	0.16	0.25	0.91	0.44	0.36
28						26									
29	2	1.96	2.16	3.09	XC #3	5	3.11	0.70	-0.79	0.24	0.31	0.47	1.85	0.87	0.66
30	4	2.74	2.37	3.69	XC #3	10	4.23	2.84	-2.62	0.65	0.99	1.77	5.01	2.76	2.49
SIGNAL TYPE					N % n										
1	mean	2.17	2.24	2.60	33.33	16.17	3.56	0.68	-0.63	0.18	0.25	0.41	1.43	0.69	0.57
	std. dev	0.11	0.05	0.68			0.17	0.44	0.37	0.12	0.16	0.27	0.91	0.45	0.38
2	mean	1.87	2.08	5.23	33.33	13.83	3.01	1.03	-1.03	0.36	0.46	0.66	2.80	1.27	0.93
	std. dev	0.54	0.24	1.96			0.91	0.94	0.82	0.26	0.35	0.59	1.98	0.98	0.82
3	mean	2.60	2.50	4.93	11.11	14.25	3.88	3.07	-2.46	0.70	1.04	1.84	5.44	2.90	2.59
	std. dev	0.55	0.20	0.44			0.67	0.35	0.85	0.04	0.14	0.48	0.30	0.39	0.67
4	mean	2.71	2.37	3.26	22.22	12.79	4.21	1.64	-1.83	0.42	0.63	1.14	3.24	1.74	1.61
	std. dev	0.10	0.04	0.57			0.21	1.20	0.67	0.28	0.39	0.69	2.17	1.09	0.97

YM109DRV.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M109A3		Driver		Y			Oct 1/92					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
													RMS	RMQ	RMT
7	3	2.27	2.37	3.30	profile IV south	5	3.40	0.86	-0.67	0.22	0.31	0.51	1.74	0.86	0.72
8	3	2.45	2.47	2.56	profile IV south	5	3.91	1.15	-1.33	0.32	0.45	0.77	2.45	1.26	1.09
9	4	2.86	2.24	2.49	profile IV north	10	4.25	1.90	-1.29	0.38	0.54	1.08	2.92	1.51	1.51
10	1	2.23	2.24	2.60	profile IV south	10	3.58	1.30	-1.48	0.39	0.52	0.86	3.01	1.46	1.22
13	2	1.70	1.90	6.77	6" WB	5	2.56	1.76	-1.51	0.64	0.77	1.08	4.93	2.15	1.53
14	2	2.08	2.09	5.05	6" WB	10	3.37	1.40	-1.17	0.38	0.50	0.79	2.95	1.39	1.11
15	1	2.17	2.17	3.73	paved	6	3.66	0.43	-0.46	0.12	0.16	0.27	0.95	0.45	0.38
18	2	1.91	2.09	5.20	paved	8	3.17	0.53	-0.49	0.16	0.20	0.30	1.24	0.57	0.43
19	1	2.24	2.16	2.71	paved	10	3.72	0.59	-0.67	0.17	0.22	0.38	1.31	0.62	0.53
20	2	2.03	2.17	4.91	paved	12	3.44	0.82	-0.74	0.23	0.30	0.46	1.76	0.82	0.65
21	2	2.43	2.20	4.23	paved	14	4.14	0.83	-1.13	0.24	0.32	0.58	1.83	0.88	0.81
22	2	2.02	2.22	7.71	paved	16	3.30	1.82	-1.47	0.50	0.66	1.01	3.87	1.83	1.42
23	2	2.06	2.16	5.05	paved	18	3.62	0.89	-0.98	0.26	0.34	0.53	2.00	0.94	0.75
25	2	2.12	2.26	4.73	paved	20	3.41	0.80	-0.88	0.25	0.33	0.52	1.91	0.92	0.73
26	1	2.05	2.17	3.51	paved	22	3.43	0.77	-0.77	0.23	0.30	0.46	1.75	0.82	0.65
27	1	2.06	2.18	2.61	paved	24	3.52	0.66	-0.59	0.18	0.23	0.37	1.38	0.65	0.52
28						26									
29	1	2.32	2.19	2.86	XC #3	5	3.83	0.67	-0.62	0.17	0.23	0.39	1.30	0.63	0.55
30	4	2.66	2.53	4.62	XC #3	10	4.08	2.11	-2.47	0.56	0.84	1.49	4.34	2.34	2.10
SIGNAL TYPE					N % n										
1	mean	2.18	2.18	3.00	33.33	16.17	3.62	0.74	-0.77	0.21	0.28	0.45	1.62	0.77	0.64
	std. dev	0.11	0.03	0.49			0.14	0.30	0.36	0.09	0.13	0.21	0.73	0.35	0.30
2	mean	2.04	2.13	5.45	44.44	13.83	3.38	1.11	-1.04	0.33	0.43	0.66	2.56	1.19	0.93
	std. dev	0.20	0.11	1.17			0.44	0.48	0.35	0.16	0.20	0.27	1.26	0.55	0.39
3	mean	2.36	2.42	2.93	11.11	14.25	3.66	1.00	-1.00	0.27	0.38	0.64	2.09	1.06	0.90
	std. dev	0.13	0.07	0.53			0.36	0.21	0.47	0.07	0.10	0.19	0.50	0.28	0.26
4	mean	2.76	2.38	3.56	11.11	12.79	4.16	2.01	-1.88	0.47	0.69	1.28	3.63	1.93	1.81
	std. dev	0.14	0.20	1.50			0.11	0.15	0.83	0.13	0.21	0.30	1.01	0.58	0.42

ZM109DRV.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M109A3		Driver		Z			Oct. 1/92					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
7	4	2.77	2.35	2.46	profile IV south	5	4.73	3.09	-3.11	0.66	0.96	1.81	5.08	2.67	2.55
8	4	2.56	2.41	3.01	profile IV south	5	4.17	5.50	-4.17	1.16	1.66	2.97	8.99	4.62	4.18
9	4	2.75	2.41	2.57	profile IV north	10	4.56	6.76	-5.92	1.39	2.09	3.83	10.77	5.81	5.38
10	4	2.58	2.33	2.19	profile IV south	10	4.15	7.09	-6.25	1.61	2.35	4.15	12.44	6.55	5.84
13	2	1.62	1.82	5.73	6' WB	5	2.35	7.15	-6.40	2.88	3.44	4.67	22.31	9.57	6.57
14	2	1.94	2.21	4.59	6' WB	10	3.06	5.96	-6.26	2.00	2.65	3.87	15.47	7.38	5.44
15	2	2.23	2.13	4.10	paved	6	3.43	1.75	-1.17	0.43	0.56	0.95	3.31	1.56	1.34
18	2	1.83	2.00	6.58	paved	8	2.78	1.72	-1.45	0.57	0.71	1.04	4.41	1.98	1.47
19	1	2.23	2.17	3.29	paved	10	3.85	1.76	-1.70	0.45	0.60	1.00	3.48	1.66	1.41
20	2	1.88	2.04	6.97	paved	12	3.03	2.14	-1.85	0.66	0.82	1.24	5.10	2.30	1.74
21	1	2.11	2.11	3.70	paved	14	3.66	1.87	-1.74	0.49	0.64	1.04	3.83	1.79	1.46
22	2	1.92	2.10	6.34	paved	16	3.00	1.95	-1.93	0.65	0.83	1.24	5.01	2.31	1.75
23	1	2.04	2.15	3.66	paved	18	3.49	1.94	-1.86	0.55	0.71	1.11	4.22	1.97	1.57
25	1	2.42	2.18	2.84	paved	20	4.25	1.68	-1.90	0.42	0.57	1.02	3.27	1.58	1.43
26	2	2.08	2.18	4.08	paved	22	3.64	1.61	-1.63	0.44	0.58	0.93	3.44	1.61	1.30
27	1	2.25	2.17	3.55	paved	24	3.93	1.92	-1.71	0.46	0.61	1.04	3.58	1.71	1.46
29	2	1.99	2.17	2.46	XC #3	5	3.24	1.19	-1.25	0.38	0.49	0.75	2.91	1.36	1.06
30	4	4.13	2.25	2.43	XC #3	10	5.46	6.64	-3.13	0.89	1.55	3.70	6.93	4.30	5.20
SIGNAL TYPE					N % n										
1	mean	2.21	2.15	3.41	27.78	16.17	3.84	1.84	-1.78	0.47	0.63	1.04	3.67	1.74	1.47
	std. dev	0.14	0.03	0.36			0.29	0.11	0.09	0.05	0.05	0.04	0.37	0.15	0.06
2	mean	1.95	2.09	4.84	44.44	13.83	3.07	3.05	-2.87	1.05	1.32	1.92	8.12	3.68	2.70
	std. dev	0.19	0.14	1.47			0.43	2.43	2.38	0.99	1.20	1.63	7.65	3.35	2.29
3	mean	n/a	n/a	n/a	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	2.96	2.35	2.53	27.78	12.79	4.61	5.82	-4.52	1.14	1.72	3.29	8.84	4.79	4.63
	std. dev	0.66	0.07	0.30			0.53	1.64	1.50	0.38	0.54	0.93	2.94	1.49	1.31

XM109GUN.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M109A3		Gunner		X			Oct. 5/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE	(mph)							RMS	RMQ	RMT
7	2	2.25	2.27	4.51	profile IV south	5	3.47	0.81	-0.91	0.25	0.34	0.56	1.92	0.94	0.78
8	3	2.48	2.37	3.19	profile IV south	5	3.85	1.47	-1.16	0.34	0.48	0.85	2.65	1.33	1.19
9	4	2.83	2.45	4.78	profile IV north	10	4.09	2.10	-2.77	0.60	0.91	1.68	4.61	2.52	2.37
10	1	2.02	2.17	3.65	profile IV south	10	3.28	1.56	-1.57	0.48	0.63	0.97	3.70	1.75	1.36
13	3	2.48	2.30	3.32	6" WB	5	3.92	1.76	-1.31	0.39	0.55	0.97	3.03	1.52	1.37
14	2	2.20	2.29	4.88	6" WB	10	3.39	1.22	-1.33	0.38	0.51	0.83	2.92	1.42	1.17
15	3	2.41	2.42	2.57	paved	6	3.66	0.34	-0.41	0.10	0.14	0.25	0.79	0.40	0.35
18	1	2.03	2.20	3.96	paved	8	3.33	0.31	-0.32	0.10	0.12	0.19	0.74	0.35	0.27
19	1	2.16	2.19	2.11	paved	10	3.58	0.51	-0.41	0.13	0.17	0.28	1.00	0.47	0.39
20	3	2.22	2.51	4.43	paved	12	3.41	0.69	-0.66	0.20	0.28	0.44	1.53	0.78	0.62
21	1	2.27	2.24	3.71	paved	14	3.60	0.50	-0.44	0.13	0.18	0.30	1.02	0.50	0.42
22	3	2.25	2.32	3.41	paved	16	3.60	0.58	-0.63	0.17	0.23	0.38	1.30	0.65	0.53
23	3	2.16	2.42	4.56	paved	18	3.38	0.83	-0.86	0.25	0.35	0.54	1.94	0.97	0.76
25	3	2.45	2.31	4.88	paved	20	3.82	0.79	-0.96	0.23	0.32	0.56	1.77	0.89	0.79
26	2	1.88	2.12	4.19	paved	22	2.91	0.56	-0.51	0.18	0.24	0.35	1.42	0.66	0.49
27	1	2.22	2.22	3.62	paved	24	3.54	0.70	-0.53	0.17	0.23	0.39	1.35	0.64	0.54
28	1	2.25	2.19	2.29	paved	26	3.73	0.52	-0.46	0.13	0.18	0.30	1.02	0.49	0.42
29	2	1.94	2.23	3.43	XC #3	5	2.99	0.41	-0.46	0.15	0.19	0.28	1.13	0.53	0.40
30	3	2.78	2.74	4.96	XC #3	10	4.14	2.60	-2.95	0.67	1.07	1.87	5.19	2.98	2.62
SIGNAL TYPE					N % n										
1	mean	2.16	2.20	3.22	31.58	15.33	3.51	0.68	-0.62	0.19	0.25	0.40	1.47	0.70	0.57
	std. dev	0.11	0.02	0.80			0.17	0.45	0.47	0.14	0.19	0.28	1.11	0.52	0.40
2	mean	2.07	2.23	4.25	21.05	10.50	3.19	0.75	-0.80	0.24	0.32	0.50	1.85	0.89	0.71
	std. dev	0.23	0.22	1.01			0.26	1.00	1.17	0.25	0.42	0.73	1.96	1.16	1.03
3	mean	2.40	2.42	3.91	42.11	11.50	3.72	1.13	-1.12	0.29	0.43	0.73	2.28	1.19	1.03
	std. dev	0.20	0.15	0.90			0.26	0.76	0.79	0.18	0.29	0.52	1.38	0.81	0.73
4	mean	2.83	2.45	4.78	0.05	10.00	4.09	2.10	-2.77	0.60	0.91	1.68	4.61	2.52	2.37
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M109A3		Gunner		Y		Oct. 5/92						British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
7	2	1.96	2.33	4.30	profile IV south	5	2.94	1.85	-1.73	0.61	0.80	1.19	4.71	2.23	1.67
8	2	2.37	2.22	4.28	profile IV south	5	3.30	3.16	-2.21	0.81	1.12	1.93	6.31	3.12	2.72
9	3	2.10	2.55	5.65	profile IV north	10	3.08	3.34	-3.37	1.09	1.51	2.29	8.43	4.20	3.22
10	3	2.06	2.37	5.96	profile IV south	10	3.08	4.79	-4.39	1.49	2.06	3.08	11.56	5.74	4.33
13	2	1.56	1.78	6.96	6" WB	5	2.16	2.77	-3.21	1.38	1.63	2.16	10.70	4.54	3.04
14	2	2.02	2.01	5.22	6" WB	10	3.07	1.39	-1.78	0.52	0.66	1.04	4.00	1.82	1.47
15	1	2.02	2.13	3.56	paved	6	3.37	0.44	-0.43	0.13	0.17	0.26	0.99	0.46	0.36
18	2	1.98	2.08	3.40	paved	8	3.35	0.54	-0.49	0.15	0.20	0.31	1.20	0.55	0.43
19	2	2.09	2.13	4.60	paved	10	3.56	0.88	-0.82	0.24	0.31	0.50	1.85	0.86	0.70
20	2	1.94	2.12	4.73	paved	12	3.21	0.68	-0.66	0.21	0.27	0.40	1.61	0.75	0.57
21	2	2.25	2.25	5.85	paved	14	3.62	1.32	-0.94	0.31	0.42	0.70	2.42	1.17	0.99
22	2	2.00	2.15	4.67	paved	16	3.46	0.73	-0.75	0.21	0.28	0.43	1.66	0.77	0.60
23	2	2.05	2.17	4.16	paved	18	3.50	0.72	-0.80	0.22	0.28	0.44	1.68	0.79	0.63
25	1	2.02	2.13	3.80	paved	20	3.48	0.81	-0.91	0.25	0.32	0.50	1.92	0.88	0.70
26	2	2.05	2.18	4.11	paved	22	3.41	1.00	-0.97	0.29	0.38	0.59	2.23	1.05	0.83
27	1	2.17	2.18	3.41	paved	24	3.74	0.78	-0.88	0.22	0.29	0.48	1.72	0.82	0.68
28	4	2.99	2.13	3.33	paved	26	4.57	1.33	-0.83	0.24	0.33	0.71	1.83	0.93	1.00
29	2	1.99	2.17	3.38	XC #3	5	3.12	0.89	-0.77	0.27	0.35	0.53	2.07	0.97	0.75
30	3	2.84	2.87	6.09	XC #3	10	4.36	4.07	-4.24	0.95	1.55	2.71	7.38	4.31	3.81
SIGNAL TYPE					N % n										
1	mean	2.07	2.15	3.59	15.79	16.67	3.53	0.68	-0.74	0.20	0.26	0.41	1.54	0.72	0.58
	std. dev	0.08	0.03	0.20			0.19	0.21	0.27	0.06	0.08	0.13	0.49	0.23	0.19
2	mean	2.02	2.13	4.64	63.16	10.83	3.23	1.33	-1.26	0.44	0.56	0.85	3.37	1.55	1.20
	std. dev	0.19	0.14	1.00			0.39	0.85	0.81	0.36	0.43	0.62	2.77	1.21	0.87
3	mean	2.33	2.60	5.90	15.79	10.00	3.50	4.07	-4.00	1.18	1.71	2.69	9.12	4.75	3.78
	std. dev	0.44	0.26	0.22			0.74	0.72	0.55	0.28	0.31	0.39	2.17	0.86	0.55
4	mean	2.99	2.13	3.33	0.05	26.00	4.57	1.33	-0.83	0.24	0.33	0.71	1.83	0.93	1.00
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

ZM109GUN.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M109A3		Gunner		Z			Oct. 5/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE	(mph)							RMS	RMQ	RMT
7	4	2.87	2.42	2.56	profile IV south	5	4.68	2.27	-2.92	0.55	0.82	1.59	4.29	2.30	2.23
8	4	2.99	2.53	3.16	profile IV south	5	4.66	6.02	-4.85	1.17	1.85	3.49	9.03	5.15	4.90
9	3	3.03	2.64	3.28	profile IV north	10	5.35	7.79	-7.60	1.44	2.28	4.36	11.13	6.34	6.13
10	4	2.70	2.48	3.14	profile IV south	10	4.11	7.67	-5.56	1.61	2.44	4.35	12.47	6.79	6.12
13	2	2.49	2.05	5.03	6" WB	5	3.25	15.10	-7.24	3.44	4.65	8.57	26.65	12.92	12.05
14	2	1.90	2.02	6.48	6" WB	10	3.01	7.57	-5.86	2.23	2.80	4.25	17.30	7.79	5.98
15	2	1.71	1.98	7.36	paved	6	2.74	1.28	-1.15	0.44	0.54	0.76	3.43	1.51	1.07
18	2	1.59	1.79	9.62	paved	8	2.44	2.44	-1.92	0.89	1.06	1.42	6.93	2.94	1.99
19	2	1.92	2.14	7.52	paved	10	3.18	2.66	-2.77	0.86	1.10	1.64	6.62	3.06	2.30
20	2	1.87	2.04	7.46	paved	12	3.20	2.69	-2.71	0.84	1.06	1.57	6.52	2.94	2.21
21	2	1.91	2.13	6.77	paved	14	3.11	2.60	-2.59	0.84	1.07	1.60	6.48	2.98	2.25
22	2	2.14	2.13	4.67	paved	16	3.75	1.68	-2.04	0.50	0.64	1.06	3.84	1.79	1.49
23	1	2.42	2.17	3.90	paved	18	4.40	2.91	-2.41	0.60	0.80	1.47	4.69	2.23	2.06
25	1	2.38	2.18	3.04	paved	20	3.99	1.40	-2.00	0.43	0.56	1.01	3.30	1.57	1.42
26	1	2.18	2.18	3.37	paved	22	3.68	2.49	-2.30	0.65	0.87	1.42	5.04	2.41	1.99
27	1	2.20	2.13	3.60	paved	24	3.66	2.44	-1.98	0.60	0.79	1.33	4.67	2.20	1.87
28	4	2.70	2.19	3.29	paved	26	4.73	2.71	-2.18	0.52	0.71	1.40	4.01	1.98	1.97
29	2	1.69	1.96	6.33	XC #3	5	2.58	1.64	-1.66	0.64	0.78	1.08	4.95	2.18	1.52
30	4	4.36	2.00	3.31	XC #3	10	5.39	7.49	-3.40	1.01	1.85	4.40	7.83	5.15	6.20
SIGNAL TYPE					N % n										
1	mean	2.30	2.16	3.48	21.05	21.00	3.93	2.31	-2.17	0.57	0.76	1.31	4.42	2.10	1.84
	std. dev	0.12	0.02	0.36			0.34	0.64	0.22	0.10	0.13	0.20	0.77	0.37	0.29
2	mean	1.91	2.03	6.80	47.37	9.56	3.03	4.18	-3.10	1.19	1.52	2.44	9.19	4.23	3.43
	std. dev	0.27	0.11	1.47			0.40	4.50	2.05	1.00	1.35	2.51	7.72	3.74	3.54
3	mean	3.03	2.64	3.28	0.05	10.00	5.35	7.79	-7.60	1.44	2.28	4.36	11.13	6.34	6.13
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	3.12	2.32	3.09	26.32	11.50	4.71	5.23	-3.78	0.97	1.54	3.04	7.53	4.27	4.28
	std. dev	0.70	0.23	0.30			0.45	2.59	1.39	0.45	0.74	1.46	3.52	2.06	2.06

M923A2

XM923U.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:				DATE OF ANALYSIS:				ANALYSIS METHOD:			
XM923		Unknown		X				Oct 3, 1992				British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
3	2	2.17	2.26	8.90	Munson grave	25	3.50	3.47	-3.17	0.95	1.28	2.06	7.34	3.55	2.89
5	3	2.23	2.32	7.72	Munson grave	35	3.53	3.52	-3.17	0.95	1.30	2.11	7.33	3.61	2.97
6	2	2.25	2.27	6.95	Munson grave	15	3.55	3.50	-3.16	0.94	1.28	2.11	7.26	3.55	2.97
7	2	2.18	2.12	7.70	Munson bel blk	5	3.53	3.80	-4.48	1.17	1.55	2.56	9.09	4.31	3.60
10	4	2.52	2.37	6.97	Munson bel blk	20	3.76	12.73	-9.36	2.94	4.16	7.40	22.74	11.59	10.40
16	2	2.35	2.14	6.72	Perry paved	40	3.59	2.75	-1.75	0.63	0.83	1.47	4.86	2.31	2.07
21	2	2.02	2.23	7.33	Perry paved	65	3.26	2.68	-2.47	0.79	1.04	1.59	6.12	2.89	2.24
24	4	2.84	2.31	6.20	Perry 1	20	4.54	4.55	-3.42	0.88	1.30	2.50	6.80	3.60	3.51
27	2	2.28	2.26	4.25	Perry 1	35	3.70	2.00	-2.01	0.54	0.74	1.23	4.19	2.06	1.74
28	2	2.22	2.17	7.20	Perry A	5	3.63	2.62	-2.09	0.65	0.86	1.44	5.03	2.39	2.03
30	3	2.32	2.34	10.26	Perry A	15	3.77	3.99	-3.91	1.05	1.45	2.43	8.12	4.05	3.42
32	4	3.01	2.34	7.58	Perry A	25	4.82	5.98	-5.56	1.20	1.88	3.60	9.26	5.23	5.06
33	4	2.63	2.34	7.60	Perry #2	5	4.77	2.59	-3.04	0.59	0.84	1.55	4.57	2.34	2.18
35	4	3.33	2.46	9.30	Perry #2	15	5.04	14.65	-8.90	2.34	3.58	7.78	18.09	9.96	10.94
38	4	2.57	2.36	7.54	Perry #3	5	3.90	3.78	-2.69	0.83	1.18	2.13	6.42	3.28	3.00
40	2	1.89	2.07	7.78	Perry #3	15	2.97	15.80	-12.60	4.78	6.05	9.05	37.06	16.83	12.73
SIGNAL TYPE					N % n										
1	mean	n/a	n/a	n/a	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	std. dev	n/a	n/a	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2	mean	2.17	2.19	7.10	50.00	25.63	3.47	4.58	-3.97	1.31	1.70	2.69	10.12	4.74	3.78
	std. dev	0.15	0.08	1.33		20.43	0.24	4.57	3.60	1.42	1.78	2.61	11.00	4.95	3.67
3	mean	2.28	2.33	8.99	12.50	25.00	3.65	3.75	-3.54	1.00	1.38	2.27	7.72	3.83	3.19
	std. dev	0.06	0.01	1.80		14.14	0.17	0.34	0.53	0.07	0.11	0.23	0.56	0.31	0.32
4	mean	2.82	2.36	7.53	37.50	15.00	4.47	7.38	-5.50	1.46	2.16	4.16	11.32	6.00	5.85
	std. dev	0.31	0.05	1.02		8.37	0.52	5.05	2.99	0.95	1.38	2.74	7.35	3.85	3.85

YM923U.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:				DATE OF ANALYSIS:				ANALYSIS METHOD:			
XM923		Unknown		Y				Oct 3, 1992				British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
3	3	2.44	2.43	5.66	Munson grave	25	4.11	1.54	-1.33	0.35	0.49	0.85	2.71	1.38	1.20
5	4	3.45	2.41	4.31	Munson grave	35	5.99	2.29	-2.92	0.43	0.66	1.50	3.37	1.84	2.11
6	4	2.60	2.34	5.34	Munson grave	15	4.57	1.29	-1.43	0.30	0.42	0.77	2.30	1.17	1.09
7	1	2.32	2.15	3.79	Munson bel bl	5	3.77	1.34	-1.24	0.34	0.46	0.79	2.65	1.29	1.12
10	4	2.82	2.23	4.83	Munson bel bl	20	4.98	4.80	-4.47	0.93	1.33	2.63	7.22	3.69	3.69
16	2	2.13	2.23	5.49	Perry paved	40	3.55	1.46	-1.27	0.39	0.51	0.82	2.99	1.43	1.16
21	2	2.33	2.25	4.19	Perry paved	65	3.86	1.71	-1.41	0.40	0.55	0.94	3.13	1.54	1.32
24	4	2.73	2.37	5.80	Perry 1	20	4.76	2.06	-1.85	0.41	0.61	1.12	3.18	1.70	1.58
27	4	2.50	2.39	4.28	Perry 1	35	4.27	1.38	-1.35	0.32	0.46	0.80	2.48	1.27	1.13
28	2	2.34	2.21	5.30	Perry A	5	3.70	0.74	-0.57	0.18	0.24	0.41	1.36	0.66	0.58
30	4	3.33	2.40	4.83	Perry A	15	5.86	1.10	-1.65	0.23	0.35	0.78	1.82	0.98	1.10
32	4	3.75	2.40	5.83	Perry A	25	6.45	3.58	-3.71	0.56	1.01	2.12	4.38	2.81	2.98
33	4	4.10	2.28	4.68	Perry #2	5	6.25	0.81	-1.75	0.20	0.33	0.84	1.58	0.91	1.18
35	3	2.46	2.47	3.99	Perry #2	15	3.90	1.42	-1.60	0.39	0.56	0.95	3.00	1.56	1.34
38	2	2.07	2.22	5.46	Perry #3	5	3.29	1.01	-1.05	0.31	0.42	0.65	2.43	1.16	0.91
40	4	2.62	2.22	3.83	Perry #3	15	4.54	4.21	-4.05	0.91	1.28	2.38	7.04	3.57	3.34
SIGNAL TYPE					N % n										
1	mean	2.32	2.15	3.79	6.25	5.00	3.77	1.34	-1.24	0.34	0.46	0.79	2.65	1.29	1.12
	std. dev	n/a	n/a	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2	mean	2.26	2.23	4.99	18.75	36.67	3.70	1.30	-1.08	0.32	0.43	0.72	2.49	1.21	1.02
	std. dev	0.12	0.02	0.70		30.14	0.15	0.50	0.45	0.13	0.17	0.28	0.98	0.48	0.39
3	mean	2.45	2.45	4.83	12.50	20.00	4.01	1.48	-1.46	0.37	0.53	0.90	2.85	1.47	1.27
	std. dev	0.01	0.03	1.18		7.07	0.15	0.09	0.19	0.03	0.05	0.07	0.21	0.13	0.10
4	mean	3.10	2.34	4.86	56.25	20.56	5.30	2.39	-2.58	0.48	0.72	1.44	3.71	1.99	2.02
	std. dev	0.57	0.07	0.69		9.82	0.83	1.46	1.23	0.27	0.39	0.75	2.12	1.09	1.05

ZM923U.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:				DATE OF ANALYSIS:				ANALYSIS METHOD:			
XM923		Unknown		Z				Oct 3, 1992				British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE	(mph)							RMS	RMQ	RMT
3	4	3.25	2.36	4.50	Munson grave	25	5.68	3.86	-4.71	0.75	1.15	2.45	5.84	3.19	3.45
5	4	3.34	2.26	4.32	Munson grave	35	6.37	6.26	-6.65	1.01	1.52	3.38	7.85	4.22	4.76
6	3	2.35	2.31	4.61	Munson grave	15	3.99	3.57	-3.23	0.85	1.18	2.00	6.60	3.28	2.82
7	1	2.12	2.18	3.31	Munson bel blk	5	3.64	2.41	-2.34	0.65	0.86	1.39	5.07	2.41	1.95
10	2	2.22	2.27	4.08	Munson bel blk	20	3.82	9.43	-8.66	2.37	3.21	5.25	18.35	8.93	7.38
16	1	2.30	2.17	3.37	Perry paved	40	4.20	3.75	-3.45	0.86	1.15	1.97	6.64	3.19	2.77
21	2	2.35	2.13	6.70	Perry paved	65	4.58	7.36	-6.63	1.53	2.03	3.59	11.82	5.65	5.05
24	4	5.16	2.28	5.03	Perry 1	20	9.63	13.80	-8.74	1.17	1.90	6.03	9.06	5.29	8.48
27	4	3.14	2.27	5.42	Perry 1	35	5.61	6.61	-6.35	1.16	1.77	3.62	8.95	4.94	5.10
28	1	2.30	2.18	2.78	Perry A	5	4.25	1.23	-1.37	0.31	0.41	0.71	2.37	1.14	0.99
30	4	8.44	2.17	4.31	Perry A	15	12.03	2.91	-11.23	0.59	1.17	4.96	4.55	3.25	6.98
32	4	5.85	2.30	4.50	Perry A	25	10.16	7.28	-13.78	1.04	1.79	6.06	8.03	4.98	8.52
33	4	20.93	1.86	2.38	Perry #2	5	27.47	2.70	-18.26	0.38	1.74	7.98	2.96	4.85	11.23
35	4	5.55	2.26	3.69	Perry #2	15	8.79	3.88	-9.25	0.75	1.20	4.15	5.78	3.35	5.83
38	1	2.18	2.21	2.84	Perry #3	5	3.74	1.54	-1.35	0.39	0.51	0.84	2.99	1.43	1.18
40	4	3.41	2.35	3.65	Perry #3	15	6.40	6.18	-5.56	0.92	1.43	3.12	7.10	3.98	4.39
SIGNAL TYPE					N % n										
1	mean	2.22	2.19	3.07	25.00	13.75	3.96	2.23	-2.13	0.55	0.73	1.22	4.27	2.04	1.72
	std. dev	0.09	0.02	0.31		17.50	0.31	1.13	1.00	0.25	0.34	0.58	1.96	0.94	0.81
2	mean	2.28	2.20	5.39	12.50	42.50	4.20	8.40	-7.64	1.95	2.62	4.42	15.09	7.29	6.22
	std. dev	0.10	0.10	1.85		31.82	0.54	1.46	1.44	0.60	0.83	1.17	4.62	2.32	1.65
3	mean	2.35	2.31	4.61	6.25	15.00	3.99	3.57	-3.23	0.85	1.18	2.00	6.60	3.28	2.82
	std. dev	n/a	n/a	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	6.56	2.23	4.20	56.25	21.11	10.24	5.94	-9.39	0.86	1.52	4.64	6.68	4.23	6.53
	std. dev	5.66	0.15	0.88		9.93	6.84	3.40	4.40	0.27	0.30	1.77	2.06	0.83	2.50

M1076

XM1076DR.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
XM1076		Driver		X			Oct. 5/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
1	4	2.72	2.23	3.88	bel blk	20	4.30	2.66	-2.02	0.54	0.76	1.48	4.22	2.12	2.08
2	2	2.48	2.25	4.49	bel blk	25	4.10	4.17	-3.60	0.95	1.30	2.35	7.33	3.62	3.30
3	2	1.85	2.05	8.27	2" wash brd	8	2.63	1.30	-1.68	0.57	0.72	1.04	4.38	1.99	1.47
4	2	2.12	2.15	11.17	2" wash brd	10	3.40	3.06	-3.19	0.92	1.22	1.95	7.12	3.39	2.74
5	3	2.26	2.33	3.81	radial WB	10	3.67	1.63	-1.89	0.48	0.66	1.08	3.71	1.85	1.52
6	4	2.58	2.43	4.86	radial WB	15	4.09	2.48	-2.87	0.65	0.95	1.69	5.07	2.65	2.37
7	2	2.09	2.20	4.26	sp bump	15	3.28	1.60	-1.71	0.50	0.67	1.06	3.91	1.87	1.49
8	1	2.05	2.13	3.49	sp bump	20	3.26	2.08	-2.29	0.67	0.87	1.37	5.18	2.43	1.93
9	1	2.28	2.19	3.47	w/trailer bel blk	20	3.77	3.36	-3.66	0.93	1.25	2.12	7.21	3.47	2.98
10	3	2.26	2.32	3.61	w/trailer bel blk	25	3.61	5.26	-5.32	1.46	2.02	3.30	11.33	5.61	4.64
11	1	2.23	2.12	3.84	w/trailer 2" WB	8	3.68	1.58	-1.79	0.46	0.60	1.02	3.54	1.68	1.44
12	2	1.67	1.78	8.42	w/trailer 2" WB	10	2.63	3.35	-3.49	1.30	1.54	2.17	10.06	4.28	3.05
13	2	2.06	2.26	4.32	w/trailer sp bum	15	3.05	3.31	-3.32	1.09	1.46	2.24	8.41	4.05	3.14
14	2	2.06	2.22	6.50	w/trailer sp bum	20	3.11	5.77	-4.97	1.73	2.27	3.56	13.37	6.32	5.01
15	4	2.81	2.43	5.55	w/trailer rad. WB	10	3.99	3.17	-4.98	1.02	1.52	2.88	7.92	4.22	4.04
16	4	2.96	2.40	5.34	w/trailer rad. WB	15	4.54	4.23	-6.24	1.15	1.72	3.41	8.93	4.78	4.80
SIGNAL TYPE					N % n										
1	mean	2.19	2.15	3.60	18.75	16.00	3.57	2.34	-2.58	0.69	0.91	1.50	5.31	2.53	2.11
	std. dev	0.12	0.04	0.21			0.27	0.92	0.97	0.24	0.32	0.56	1.84	0.90	0.79
2	mean	2.05	2.13	6.78	43.75	14.71	3.17	3.22	-3.14	1.01	1.31	2.05	7.80	3.64	2.89
	std. dev	0.25	0.17	2.64			0.50	1.52	1.14	0.42	0.54	0.86	3.27	1.51	1.21
3	mean	2.26	2.33	3.71	12.50	17.50	3.64	3.44	-3.60	0.97	1.34	2.19	7.52	3.73	3.08
	std. dev	0.00	0.01	0.14			0.04	2.57	2.43	0.70	0.96	1.57	5.39	2.66	2.21
4	mean	2.77	2.37	4.91	25.00	15.00	4.23	3.13	-4.03	0.84	1.24	2.36	6.53	3.44	3.32
	std. dev	0.16	0.10	0.74			0.24	0.78	1.93	0.29	0.45	0.93	2.25	1.26	1.31

YM1076DR.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
XM1076		Driver		Y			Oct. 5/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE					(mph)							RMS	RMQ	RMT
1	2	1.97	2.24	3.07	bel blk	20	3.00	1.27	-1.29	0.43	0.56	0.84	3.30	1.56	1.18
2	4	2.57	2.23	3.51	bel blk	25	4.12	1.98	-2.48	0.54	0.75	1.39	4.19	2.09	1.96
3	2	2.02	2.18	7.39	2" wash brd	8	3.17	1.57	-1.50	0.48	0.63	0.97	3.74	1.77	1.37
4	2	2.21	2.23	7.27	2" wash brd	10	3.43	1.10	-1.38	0.36	0.48	0.80	2.79	1.33	1.12
5	1	2.14	2.20	3.97	radial WB	10	3.68	1.48	-1.53	0.41	0.54	0.88	3.17	1.51	1.23
6	1	2.26	2.29	3.15	radial WB	15	3.75	1.91	-1.71	0.48	0.65	1.09	3.73	1.82	1.53
7	2	2.08	2.21	4.29	sp bump	15	3.21	0.99	-1.32	0.36	0.47	0.75	2.80	1.32	1.05
8	1	2.11	2.23	3.20	sp bump	20	3.25	1.39	-1.52	0.45	0.60	0.94	3.47	1.68	1.33
9	1	2.09	2.18	3.80	w/trailer bel blk	20	3.35	2.34	-2.01	0.65	0.86	1.36	5.02	2.39	1.91
10	1	2.33	2.20	2.97	w/trailer bel blk	25	3.78	3.57	-3.38	0.92	1.25	2.14	7.13	3.48	3.02
11	2	1.83	2.08	6.60	w/trailer 2" WB	8	2.84	1.98	-1.98	0.70	0.88	1.27	5.40	2.46	1.79
12	2	2.04	2.11	7.37	w/trailer 2" WB	10	2.98	1.67	-2.22	0.65	0.85	1.33	5.06	2.35	1.87
13	1	2.20	2.21	2.88	w/trailer sp bump	15	3.51	1.76	-1.93	0.53	0.70	1.16	4.07	1.96	1.63
14	2	2.22	2.27	4.62	w/trailer sp bump	20	3.50	2.56	-2.86	0.78	1.05	1.72	6.01	2.93	2.42
15	3	2.28	2.43	4.02	w/trailer rad. WB	10	3.62	2.40	-2.34	0.66	0.92	1.49	5.08	2.57	2.10
16	3	2.45	2.54	3.86	w/trailer rad. WB	15	3.66	3.01	-3.45	0.88	1.28	2.16	6.84	3.56	3.04
SIGNAL TYPE					N % n										
1	mean	2.19	2.22	3.33	37.50	17.50	3.55	2.07	-2.01	0.57	0.77	1.26	4.43	2.14	1.77
	std. dev	0.09	0.04	0.45			0.22	0.81	0.70	0.19	0.26	0.46	1.47	0.72	0.65
2	mean	2.05	2.19	5.80	43.75	13.00	3.16	1.59	-1.79	0.54	0.70	1.10	4.16	1.96	1.54
	std. dev	0.14	0.07	1.78			0.24	0.55	0.59	0.17	0.22	0.36	1.32	0.63	0.50
3	mean	2.36	2.48	3.94	12.50	12.50	3.64	2.71	-2.89	0.77	1.10	1.83	5.96	3.06	2.57
	std. dev	0.12	0.08	0.11			0.03	0.43	0.79	0.16	0.25	0.48	1.25	0.70	0.67
4	mean	2.57	2.23	3.51	6.25	25.00	4.12	1.98	-2.48	0.54	0.75	1.39	4.19	2.09	1.96
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

ZM1076DR.XLS

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
XM1076		Driver		Z			Oct. 5/92					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
													RMS	RMQ	RMT
1	1	2.37	2.24	3.97	bel blk	20	3.91	5.42	-5.75	1.43	1.96	3.39	11.05	5.44	4.76
2	4	2.71	2.30	2.64	bel blk	25	4.79	7.86	-8.03	1.66	2.38	4.50	12.85	6.61	6.32
3	2	1.85	2.01	7.82	2" wash brd	8	2.84	3.94	-4.10	1.42	1.78	2.62	10.97	4.95	3.68
4	2	2.17	2.22	5.32	2" wash brd	10	3.48	3.66	-2.82	0.93	1.24	2.02	7.21	3.45	2.85
5	4	3.35	2.33	5.03	radial WB	10	5.79	9.14	-8.69	1.54	2.46	5.15	11.92	6.84	7.25
6	4	2.69	2.58	5.39	radial WB	15	4.25	6.78	-8.54	1.80	2.71	4.85	13.96	7.55	6.82
7	4	2.82	2.32	5.52	sp bump	15	3.69	4.11	-8.28	1.68	2.47	4.73	13.00	6.87	6.65
8	4	2.94	2.15	3.75	sp bump	20	3.78	4.44	-9.90	1.90	2.66	5.58	14.67	7.40	7.85
9	2	1.92	2.17	3.32	w/trailer bel blk	20	3.03	7.06	-6.95	2.31	3.00	4.45	17.92	8.34	6.26
10	4	2.77	2.32	2.72	w/trailer bel blk	25	4.43	11.01	-16.90	3.15	4.45	8.73	24.39	12.39	12.28
11	2	1.93	2.09	5.48	w/trailer 2" WB	8	3.10	5.46	-6.27	1.89	2.42	3.66	14.67	6.73	5.15
12	2	2.05	2.15	4.34	w/trailer 2" WB	10	3.19	7.98	-6.83	2.32	3.04	4.76	17.99	8.47	6.69
13	2	2.44	2.17	5.41	w/trailer sp bump	15	3.59	10.19	-14.94	3.50	4.79	8.55	27.11	13.34	12.02
14	4	2.55	2.08	4.02	w/trailer sp bump	20	4.13	17.48	-15.30	3.97	5.45	10.11	30.73	15.17	14.22
15	4	2.82	2.37	5.19	w/trailer rad. WB	10	4.10	8.31	-12.51	2.54	3.72	7.17	19.67	10.36	10.08
16	4	4.30	2.59	4.28	w/trailer rad. WB	15	7.02	29.29	-21.02	3.58	6.28	15.42	27.75	17.47	21.68
SIGNAL TYPE					N % n										
1	mean	2.37	2.24	3.97	6.25	20.00	3.91	5.42	-5.75	1.43	1.96	3.39	11.05	5.44	4.76
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2	mean	2.06	2.13	5.28	37.50	11.83	3.20	6.38	-6.98	2.06	2.71	4.34	15.98	7.55	6.11
	std. dev	0.22	0.07	1.50			0.29	2.52	4.23	0.89	1.24	2.31	6.86	3.44	3.25
3	mean	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	3.00	2.34	4.28	56.25	17.22	4.67	10.93	-12.13	2.42	3.62	7.36	18.77	10.07	10.35
	std. dev	0.54	0.17	1.10			1.08	7.95	4.65	0.93	1.46	3.60	7.17	4.07	5.07

M2HS Bradley

XM2HSCOM.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:				DATE OF ANALYSIS:				ANALYSIS METHOD:			
M2HS Bradley		Commander		X				Oct 3, 1992				British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE	(mph)							RMS	RMQ	RMT
1	1	2.03	2.16	3.12	gravel	5	3.47	0.30	-0.25	0.08	0.10	0.16	0.62	0.29	0.23
3	4	4.08	2.35	2.05	gravel	15	5.78	0.83	-0.48	0.11	0.21	0.46	0.88	0.59	0.65
5	1	2.04	2.18	2.84	gravel	25	3.36	0.57	-0.46	0.15	0.20	0.31	1.18	0.56	0.44
8	4	2.65	2.27	2.52	gravel	35	4.00	0.57	-0.37	0.12	0.16	0.31	0.90	0.46	0.43
9	2	1.34	1.58	9.15	6" wshbrd	5	1.69	1.64	-1.46	0.92	1.05	1.23	7.09	2.91	1.73
11	2	2.06	2.23	4.26	6" wshbrd	15	3.13	1.04	-0.92	0.31	0.41	0.64	2.42	1.15	0.90
13	2	1.81	2.00	4.66	6" wshbrd	25	3.05	1.02	-0.93	0.32	0.39	0.58	2.48	1.10	0.82
14	3	2.17	2.32	2.86	sec-A	5	3.54	0.32	-0.30	0.09	0.12	0.19	0.67	0.33	0.26
16	4	2.52	2.37	3.56	sec-A	15	3.89	0.74	-0.59	0.17	0.25	0.43	1.32	0.68	0.60
19	3	2.88	2.82	5.90	sec-A	25	3.64	0.97	-0.56	0.21	0.34	0.60	1.63	0.93	0.85
20	3	2.86	2.80	3.72	XC #3	5	3.85	0.87	-0.64	0.20	0.32	0.56	1.52	0.88	0.79
22	2	1.98	2.34	8.04	XC #3	15	2.87	4.34	-4.20	1.49	1.99	2.94	11.50	5.55	4.14
23	2	2.09	2.29	7.99	XC #3	20	3.08	9.83	-7.99	2.90	3.91	6.07	22.45	10.89	8.53
24	1	2.48	2.26	2.96	paved	6	4.18	0.32	-0.26	0.07	0.10	0.17	0.54	0.27	0.24
26	2	1.97	2.09	4.66	paved	10	3.36	0.48	-0.40	0.13	0.17	0.26	1.02	0.47	0.36
28	2	1.86	2.02	7.90	paved	14	3.04	0.51	-0.47	0.16	0.20	0.30	1.26	0.57	0.43
30	1	2.26	2.19	3.22	paved	18	3.75	0.28	-0.29	0.08	0.10	0.17	0.59	0.28	0.24
32	2	1.90	1.98	6.29	paved	22	3.29	0.46	-0.53	0.15	0.19	0.29	1.17	0.52	0.40
34	1	2.22	2.19	3.43	paved	26	3.97	0.44	-0.47	0.11	0.15	0.25	0.88	0.42	0.36
36	4	2.79	2.19	2.45	paved	30	4.50	0.37	-0.51	0.10	0.14	0.27	0.76	0.38	0.38
38	1	2.20	2.18	2.39	paved	34	4.08	0.36	-0.39	0.09	0.12	0.20	0.72	0.34	0.29
40	1	2.32	2.24	2.08	paved	38	3.80	0.50	-0.36	0.11	0.15	0.26	0.87	0.42	0.37
42	4	2.72	2.47	4.82	CC #3	10	3.57	1.87	-1.16	0.42	0.63	1.15	3.28	1.75	1.62
44	3	3.16	2.66	5.95	CC #3	20	4.18	2.95	-6.00	1.07	1.77	3.38	8.29	4.91	4.75
SIGNAL TYPE					N % n										
1	mean	2.22	2.20	2.86	29.1	21.71	3.80	0.40	-0.35	0.10	0.13	0.22	0.77	0.37	0.31
	std. dev	0.16	0.04	0.48		12.82	0.30	0.11	0.09	0.03	0.04	0.06	0.22	0.10	0.08
2	mean	1.89	2.05	6.08	33.3	14.86	5.28	2.77	-1.99	0.71	1.03	1.53	6.06	2.97	2.18
	std. dev	0.24	0.25	2.52		6.47	6.78	3.17	2.78	1.06	1.32	2.04	7.63	3.62	2.85
3	mean	2.77	2.65	4.61	16.6	13.75	3.80	1.28	-1.87	0.39	0.63	1.18	3.03	1.76	1.66
	std. dev	0.42	0.23	1.56		10.31	0.28	1.15	2.75	0.46	0.76	1.48	3.54	2.12	2.07
4	mean	2.95	2.33	3.08	20.8	21.00	4.35	0.88	-0.62	0.18	0.28	0.53	1.43	0.77	0.74
	std. dev	0.64	0.10	1.12		10.84	0.87	0.58	0.31	0.14	0.20	0.36	1.06	0.56	0.51

YM2HSCOM.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:				DATE OF ANALYSIS:				ANALYSIS METHOD:			
M2HS Bradley		Commander		Y				Oct. 3, 1992				British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
1	1	2.08	2.18	3.32	gravel	5	3.45	0.37	-0.31	0.10	0.13	0.20	0.76	0.36	0.29
3	1	2.29	2.20	3.79	gravel	15	3.86	0.62	-0.75	0.18	0.24	0.41	1.38	0.67	0.58
5	1	2.23	2.25	3.62	gravel	25	3.87	0.94	-0.98	0.25	0.33	0.55	1.92	0.93	0.78
8	4	3.23	2.60	2.05	gravel	35	4.54	2.02	-1.30	0.37	0.65	1.18	2.83	1.76	1.66
9	2	1.89	2.13	4.05	6" wshbrd	5	2.72	0.63	-0.76	0.26	0.33	0.48	1.98	0.92	0.68
11	3	2.43	2.35	3.02	6" wshbrd	15	3.84	1.08	-0.96	0.27	0.38	0.65	2.06	1.03	0.91
13	1	2.31	2.17	2.82	6" wshbrd	25	4.00	1.11	-0.89	0.25	0.33	0.58	1.94	0.92	0.81
14	4	2.65	2.28	3.68	sec-A	5	3.99	0.60	-0.44	0.13	0.19	0.35	1.01	0.51	0.49
16	4	2.79	2.38	3.58	sec-A	15	4.19	0.89	-1.39	0.27	0.39	0.76	2.11	1.10	1.06
19	3	3.93	2.95	3.36	sec-A	25	4.71	0.63	-1.49	0.23	0.45	0.89	1.75	1.24	1.25
24	2	2.05	2.22	4.66	paved	6	3.34	0.29	-0.25	0.08	0.11	0.17	0.63	0.30	0.23
26	4	2.74	2.20	2.89	paved	10	4.25	0.27	-0.39	0.08	0.11	0.21	0.60	0.30	0.30
28	2	2.10	2.13	6.01	paved	14	3.48	0.33	-0.39	0.10	0.13	0.22	0.80	0.37	0.30
30	2	2.07	2.11	4.43	paved	18	3.70	0.37	-0.41	0.11	0.14	0.22	0.82	0.38	0.31
32	1	2.14	2.21	3.75	paved	22	3.65	0.35	-0.39	0.10	0.13	0.22	0.78	0.37	0.30
34	1	2.35	2.24	2.62	paved	26	4.19	0.44	-0.52	0.11	0.16	0.27	0.89	0.43	0.38
36	1	2.16	2.21	2.54	paved	30	3.70	0.53	-0.47	0.14	0.18	0.29	1.05	0.50	0.41
38	1	2.27	2.23	2.17	paved	34	3.90	0.42	-0.37	0.10	0.14	0.23	0.79	0.38	0.32
40	1	2.33	2.21	3.15	paved	38	4.21	0.57	-0.51	0.13	0.17	0.30	1.00	0.48	0.42
42	3	2.62	2.77	6.05	CC #3	10	3.77	2.11	-2.49	0.61	0.94	1.60	4.73	2.62	2.25
44	4	3.05	2.36	6.93	CC #3	20	4.19	3.18	-7.01	1.22	1.78	3.71	9.41	4.95	5.21
SIGNAL TYPE					N % n										
1	mean	2.24	2.21	3.09	42.86	24.44	3.87	0.59	-0.58	0.15	0.20	0.34	1.17	0.56	0.48
	std. dev	0.09	0.03	0.58			0.25	0.26	0.24	0.06	0.08	0.14	0.47	0.23	0.20
2	mean	2.02	2.15	4.79	19.05	10.75	3.31	0.41	-0.45	0.14	0.18	0.27	1.06	0.49	0.38
	std. dev	0.09	0.05	0.86			0.42	0.15	0.22	0.08	0.10	0.14	0.62	0.29	0.20
3	mean	2.99	2.69	4.14	14.29	16.67	4.11	1.28	-1.64	0.37	0.59	1.04	2.84	1.63	1.47
	std. dev	0.82	0.31	1.66			0.52	0.76	0.78	0.21	0.31	0.49	1.64	0.86	0.70
4	mean	2.89	2.36	3.83	23.81	17.00	4.23	1.39	-2.11	0.41	0.62	1.24	3.19	1.72	1.74
	std. dev	0.24	0.15	1.85			0.20	1.20	2.78	0.46	0.68	1.43	3.59	1.89	2.01

ZM2HSCOM.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:				DATE OF ANALYSIS:				ANALYSIS METHOD:			
M2HS Bradley		Commander		Z				Oct. 3, 1992				British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	Dose (norm @ 60 sec) RMQ	Dose (norm @ 60 sec) RMT
1	2	1.85	2.05	5.90	gravel	5	2.88	1.05	-1.17	0.39	0.49	0.72	3.00	1.36	1.01
3	2	2.07	2.03	5.48	gravel	15	3.53	2.45	-2.20	0.66	0.84	1.36	5.10	2.33	1.91
5	1	2.22	2.17	3.37	gravel	25	3.92	2.35	-2.86	0.66	0.88	1.47	5.14	2.44	2.07
8	1	2.32	2.16	2.84	gravel	35	4.24	2.18	-2.11	0.51	0.68	1.17	3.91	1.88	1.65
9	2	1.86	2.10	3.30	6" wshbrd	5	2.92	1.70	-1.78	0.60	0.76	1.11	4.63	2.11	1.56
11	2	1.98	2.15	3.98	6" wshbrd	15	3.36	5.33	-4.20	1.42	1.82	2.81	10.98	5.07	3.96
13	2	1.74	1.97	5.45	6" wshbrd	25	2.94	5.63	-5.44	1.89	2.30	3.28	14.60	6.40	4.61
14	1	2.03	2.19	3.66	sec-A	5	3.34	1.13	-0.98	0.32	0.42	0.64	2.45	1.16	0.90
16	2	2.18	2.20	5.17	sec-A	15	3.88	2.36	-2.57	0.64	0.85	1.39	4.93	2.36	1.95
19	3	3.24	2.90	3.46	sec-A	25	5.64	1.98	-2.04	0.36	0.61	1.15	2.76	1.70	1.62
20	2	1.85	2.05	6.53	XC #3	5	2.96	1.28	-1.54	0.48	0.60	0.88	3.69	1.67	1.24
22	4	2.54	2.28	3.14	XC #3	15	4.20	4.12	-3.05	0.85	1.18	2.17	6.62	3.29	3.05
23	4	4.48	2.49	2.20	XC #3	20	7.83	20.28	-17.20	2.39	4.50	10.72	18.53	12.53	15.08
24	2	1.96	2.17	5.33	paved	6	3.20	1.16	-1.00	0.34	0.44	0.66	2.61	1.21	0.93
26	2	1.57	1.85	7.43	paved	10	2.44	2.58	-2.58	1.06	1.25	1.66	8.20	3.49	2.33
28	2	1.81	1.99	8.89	paved	14	2.98	2.31	-1.99	0.72	0.90	1.31	5.60	2.50	1.84
30	2	2.00	2.18	8.32	paved	18	3.42	2.70	-2.37	0.74	0.97	1.48	5.75	2.69	2.09
32	2	1.64	1.81	8.97	paved	22	2.87	3.13	-3.18	1.10	1.30	1.80	8.52	3.61	2.54
34	1	2.13	2.18	2.11	paved	26	3.63	1.69	-1.45	0.43	0.57	0.92	3.35	1.58	1.30
36	1	2.18	2.21	3.95	paved	30	3.69	1.93	-1.96	0.53	0.70	1.15	4.08	1.96	1.61
38	1	2.21	2.21	2.75	paved	34	3.74	1.77	-1.69	0.46	0.62	1.02	3.58	1.73	1.44
40	4	2.57	2.28	2.38	paved	38	4.57	1.68	-1.74	0.37	0.53	0.96	2.90	1.46	1.35
42	2	2.27	2.15	4.06	CC #3	10	4.08	3.14	-3.45	0.81	1.07	1.83	6.26	2.97	2.58
44	4	6.80	1.99	1.83	CC #3	20	12.08	15.37	-11.29	1.10	2.54	7.50	8.55	7.06	10.55
SIGNAL TYPE					N % n										
1	mean	2.18	2.19	3.11	25	25.83	3.76	1.84	-1.84	0.48	0.64	1.06	3.75	1.79	1.49
	std. dev	0.10	0.02	0.68		10.98	0.30	0.43	0.64	0.11	0.15	0.28	0.89	0.43	0.39
2	mean	1.91	2.05	6.06	54.17	11.86	3.93	4.79	-4.13	0.87	1.33	2.62	6.78	3.71	3.69
	std. dev	0.20	0.12	1.86		6.59	0.45	1.42	1.25	0.44	0.53	0.76	3.38	1.47	1.07
3	mean	3.24	2.90	3.46	4.17	25.00	5.64	1.98	-2.04	0.36	0.61	1.15	2.76	1.70	1.62
	std. dev	n/a	n/a	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	4.10	2.26	2.39	16.67	23.25	7.17	10.36	-8.32	1.18	2.19	5.34	9.15	6.09	7.51
	std. dev	2.02	0.20	0.55		10.11	3.66	8.90	7.28	0.86	1.76	4.58	6.68	4.89	6.44

XM2HSCRW.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:				DATE OF ANALYSIS:				ANALYSIS METHOD:			
M2HS Bradley		Crew		X				Oct. 3, 1992				British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
1	1	2.12	2.18	2.95	gravel	5	3.58	0.52	-0.55	0.15	0.20	0.31	1.15	0.55	0.44
3	2	1.84	2.02	4.66	gravel	15	3.09	0.95	-0.96	0.31	0.39	0.57	2.40	1.08	0.80
5	2	1.97	2.12	4.25	gravel	25	3.38	1.36	-1.37	0.40	0.52	0.79	3.13	1.44	1.12
8	3	2.42	2.42	3.59	gravel	35	3.64	1.77	-1.57	0.46	0.67	1.11	3.56	1.81	1.56
9	1	2.19	2.22	3.37	6" wshbrd	5	3.48	1.63	-1.10	0.39	0.52	0.86	3.03	1.43	1.21
11	1	2.24	2.26	2.87	6" wshbrd	15	3.87	1.96	-2.15	0.53	0.72	1.19	4.11	2.00	1.67
13	1	2.14	2.18	3.96	6" wshbrd	25	3.64	2.08	-1.84	0.54	0.71	1.15	4.17	1.97	1.62
14	1	2.19	2.13	2.23	sec-A	5	4.02	0.89	-0.96	0.23	0.30	0.51	1.79	0.84	0.71
16	2	2.03	2.10	4.79	sec-A	15	3.58	1.44	-1.44	0.40	0.52	0.82	3.11	1.44	1.15
19	3	3.72	3.15	3.61	sec-A	25	5.53	1.51	-2.26	0.34	0.65	1.27	2.64	1.80	1.79
20	4	4.85	2.19	2.90	XC #3	5	5.93	0.61	-1.97	0.22	0.40	1.05	1.68	1.10	1.48
23	3	2.06	2.32	2.97	XC #3	20	3.41	3.18	-3.01	0.91	1.22	1.87	7.02	3.39	2.63
24	1	2.35	2.16	2.53	paved	6	4.07	0.54	-0.66	0.15	0.20	0.35	1.15	0.55	0.49
26	2	1.86	2.01	3.08	paved	10	2.97	0.76	-0.91	0.28	0.35	0.52	2.18	0.98	0.74
28	2	1.80	1.98	7.24	paved	14	3.01	1.05	-1.08	0.35	0.44	0.64	2.74	1.22	0.90
30	2	1.89	2.10	6.26	paved	18	3.23	1.18	-1.37	0.39	0.50	0.75	3.06	1.39	1.05
32	2	1.84	2.01	6.87	paved	22	3.10	1.06	-1.02	0.34	0.42	0.62	2.60	1.17	0.87
34	2	2.12	2.05	4.58	paved	26	3.84	1.28	-1.14	0.31	0.40	0.67	2.44	1.11	0.94
36	2	1.90	2.07	5.86	paved	30	3.13	1.12	-1.30	0.39	0.49	0.74	3.00	1.36	1.04
38	2	2.07	2.14	4.61	paved	34	3.38	1.12	-1.35	0.37	0.47	0.76	2.83	1.32	1.06
40	1	2.18	2.17	3.19	paved	38	3.82	1.13	-0.90	0.27	0.35	0.58	2.06	0.97	0.81
42	1	2.29	2.24	2.92	CC #3	10	3.48	1.39	-2.05	0.49	0.67	1.13	3.82	1.86	1.59
44	1	2.19	2.13	3.61	CC #3	20	3.31	2.12	-3.28	0.81	1.07	1.79	6.31	2.98	2.51
SIGNAL TYPE					N % n										
1	mean	2.21	2.18	3.07	39.13	14.33	3.70	1.36	-1.50	0.40	0.53	0.87	3.07	1.46	1.23
	std. dev	0.07	0.05	0.53		11.49	0.26	0.63	0.90	0.22	0.29	0.49	1.71	0.81	0.68
2	mean	1.93	2.06	5.22	43.48	20.90	3.27	1.13	-1.19	0.35	0.45	0.69	2.75	1.25	0.97
	std. dev	0.11	0.05	1.30		7.77	0.28	0.20	0.19	0.04	0.06	0.10	0.33	0.16	0.14
3	mean	2.73	2.63	3.39	13.04	26.67	4.20	2.15	-2.28	0.57	0.85	1.42	4.41	2.33	1.99
	std. dev	0.87	0.45	0.36		7.64	1.16	0.90	0.72	0.30	0.32	0.40	2.31	0.91	0.56
4	mean	4.85	2.19	2.90	4.35	5.00	5.93	0.61	-1.97	0.22	0.40	1.05	1.68	1.10	1.48
	std. dev	n/a	n/a	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

YM2HSCRW.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:				DATE OF ANALYSIS:				ANALYSIS METHOD:			
M2HS Bradley		Crew		Y				Oct. 3, 1992				British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE	(mph)							RMS	RMQ	RMT
1	1	2.19	2.16	2.57	gravel	5	3.73	0.21	-0.23	0.06	0.08	0.13	0.45	0.22	0.18
3	2	1.77	1.97	4.68	gravel	15	2.82	0.35	-0.30	0.12	0.14	0.20	0.90	0.40	0.29
5	1	2.19	2.11	3.96	gravel	25	3.67	0.55	-0.76	0.18	0.23	0.39	1.39	0.65	0.55
8	2	2.10	2.15	4.25	gravel	35	3.64	0.75	-0.87	0.22	0.29	0.47	1.73	0.81	0.66
9	2	1.94	2.24	4.13	6" wshbrd	5	3.03	0.80	-0.75	0.26	0.34	0.50	1.99	0.95	0.70
11	1	2.33	2.23	2.87	6" wshbrd	15	3.91	1.38	-1.32	0.34	0.47	0.80	2.66	1.31	1.13
13	1	2.01	2.16	2.98	6" wshbrd	25	3.32	1.07	-1.05	0.32	0.42	0.64	2.48	1.16	0.90
14	1	2.23	2.22	3.58	sec-A	5	3.85	0.42	-0.35	0.10	0.13	0.23	0.78	0.37	0.32
16	2	2.15	2.15	5.31	sec-A	15	3.79	0.76	-0.75	0.20	0.26	0.43	1.54	0.72	0.60
19	4	3.25	2.54	4.08	sec-A	25	4.14	0.57	-1.01	0.19	0.31	0.62	1.48	0.87	0.87
20	3	2.44	2.43	2.30	XC #3	5	3.16	0.44	-0.66	0.17	0.25	0.43	1.35	0.71	0.60
23	2	2.48	2.24	4.87	XC #3	20	3.15	3.09	-1.83	0.78	1.11	1.93	6.05	3.09	2.72
24	4	4.19	2.43	4.13	paved	6	5.43	1.51	-0.74	0.21	0.37	0.87	1.60	1.03	1.22
26	2	1.49	1.72	6.99	paved	10	2.30	0.47	-0.49	0.21	0.24	0.31	1.60	0.66	0.43
28	2	2.28	2.14	7.26	paved	14	3.71	0.42	-0.57	0.13	0.18	0.30	1.03	0.49	0.43
30	2	2.00	2.10	6.55	paved	18	3.54	0.60	-0.72	0.19	0.24	0.37	1.44	0.66	0.52
32	2	2.07	2.20	4.97	paved	22	3.60	0.41	-0.39	0.11	0.15	0.23	0.86	0.40	0.32
34	2	1.93	2.01	4.64	paved	26	3.39	0.48	-0.51	0.15	0.18	0.28	1.13	0.51	0.40
36	2	2.03	2.13	6.39	paved	30	3.56	0.72	-0.70	0.20	0.26	0.41	1.55	0.72	0.57
38	1	2.31	2.18	3.76	paved	34	4.29	0.77	-0.64	0.16	0.22	0.38	1.27	0.61	0.53
40	1	2.24	2.24	2.43	paved	38	3.99	0.49	-0.50	0.12	0.17	0.28	0.97	0.47	0.39
42	4	2.76	2.57	3.69	CC #3	10	4.30	2.01	-1.65	0.42	0.66	1.17	3.29	1.83	1.65
44	4	2.86	2.51	5.10	CC #3	20	3.98	3.85	-2.34	0.78	1.18	2.22	6.01	3.27	3.12
SIGNAL TYPE					N % n										
1	mean	2.21	2.18	3.16	30.43	21.00	3.82	0.70	-0.69	0.18	0.25	0.41	1.43	0.68	0.57
	std. dev	0.11	0.05	0.60		13.15	0.30	0.40	0.39	0.11	0.15	0.24	0.84	0.41	0.33
2	mean	2.03	2.08	5.59	47.83	20.50	3.35	0.80	-0.71	0.23	0.30	0.49	1.78	0.85	0.69
	std. dev	0.27	0.15	1.10		7.84	0.47	0.82	0.43	0.20	0.29	0.51	1.53	0.80	0.72
3	mean	2.44	2.43	2.30	4.35	5.00	3.16	0.44	-0.66	0.17	0.25	0.43	1.35	0.71	0.60
	std. dev	n/a	n/a	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	3.26	2.51	4.25	17.39	15.25	4.46	1.98	-1.43	0.40	0.63	1.22	3.10	1.75	1.71
	std. dev	0.65	0.06	0.60		8.77	0.66	1.38	0.71	0.27	0.39	0.70	2.11	1.10	0.99

ZM2HSCRW.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:				DATE OF ANALYSIS:				ANALYSIS METHOD:			
M2HS Bradley		Crew		Z				Oct. 3, 1992				British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE	(mph)							RMS	RMQ	RMT
1	1	2.17	2.16	3.07	gravel	5	3.88	1.87	-1.68	0.46	0.6	0.99	3.55	1.68	1.4
3	2	1.84	1.88	6.44	gravel	15	3.25	5.27	-4.17	1.45	1.76	2.68	11.26	4.91	3.76
5	2	1.75	1.93	6.07	gravel	25	2.94	3.82	-4.5	1.42	1.73	2.48	10.97	4.82	3.49
8	2	2.16	2.09	5.26	gravel	35	3.69	4.08	-4.84	1.21	1.56	2.61	9.37	4.35	3.67
9	4	3.68	2.32	2.95	6" wshbrd	5	5.61	8.58	-4.86	1.2	1.84	4.41	9.28	5.13	6.2
11	2	1.73	1.89	4.97	6" wshbrd	15	2.53	5.8	-7.06	2.54	3.18	4.39	19.7	8.84	6.18
13	2	1.69	1.83	5.53	6" wshbrd	25	2.46	7.01	-8.92	3.25	3.89	5.49	25.15	10.83	7.72
14	2	2.2	2.21	5.16	sec-A	5	3.82	3.73	-3.13	0.9	1.19	1.98	6.95	3.32	2.78
16	2	1.84	2.01	7.34	sec-A	15	3.23	5.84	-6.06	1.84	2.29	3.39	14.28	6.38	4.77
19	3	3.48	2.95	3.81	sec-A	25	6.31	4.01	-4.06	0.64	1.12	2.22	4.96	3.12	3.13
20	1	2.13	2.16	3.85	XC #3	5	3.55	1.39	-1.44	0.4	0.52	0.85	3.08	1.46	1.19
23	4	4.98	2.05	2.06	XC #3	20	8.35	19.45	-18.7	2.28	4.87	11.37	17.69	13.56	15.99
24	4	3.07	1.98	6.09	paved	6	5.11	2.58	-3.4	0.58	0.81	1.8	4.53	2.26	2.53
26	2	1.51	1.71	6.54	paved	10	2.43	2.8	-2.8	1.15	1.32	1.74	8.91	3.68	2.45
28	2	1.94	2.02	6.58	paved	14	3.31	2.49	-2.29	0.72	0.91	1.4	5.59	2.53	1.97
30	2	1.51	1.76	12.27	paved	18	2.44	8.52	-8.84	3.55	4.11	5.37	27.53	11.45	7.55
32	2	1.71	1.87	9.11	paved	22	2.92	8.17	-7.68	2.71	3.25	4.64	21	9.04	6.52
34	2	1.7	1.85	7.52	paved	26	2.96	7.27	-7.82	2.55	3.05	4.34	19.74	8.47	6.1
36	2	2.04	2.15	4.71	paved	30	3.54	3.55	-3.92	1.05	1.37	2.15	8.17	3.81	3.03
38	3	2.48	2.36	3.67	paved	34	4.04	2.31	-1.9	0.52	0.73	1.29	4.03	2.04	1.81
40	4	2.86	2.26	2.63	paved	38	5.23	2.99	-2.91	0.56	0.81	1.62	4.37	2.25	2.27
SIGNAL TYPE					N % n										
1	mean	2.15	2.16	3.46	9.52	5.00	3.72	1.63	-1.56	0.43	0.56	0.92	3.32	1.57	1.30
	std. dev	0.03	0.00	0.55			0.23	0.34	0.17	0.04	0.06	0.10	0.33	0.16	0.15
2	mean	1.82	1.94	6.73	61.9	19.62	3.04	5.26	-5.54	1.87	2.28	3.28	14.51	6.34	4.61
	std. dev	0.22	0.15	2.07			0.48	2.03	2.32	0.94	1.09	1.41	7.29	3.02	1.98
3	mean	2.98	2.66	3.74	9.52	29.50	5.18	3.16	-2.98	0.58	0.93	1.76	4.50	2.58	2.47
	std. dev	0.71	0.42	0.10			1.61	1.20	1.53	0.08	0.28	0.66	0.66	0.76	0.93
4	mean	3.65	2.15	3.43	19.05	17.25	6.08	8.40	-7.47	1.16	2.08	4.80	8.97	5.80	6.75
	std. dev	0.95	0.16	1.81			1.53	7.86	7.53	0.81	1.92	4.56	6.25	5.35	6.42

XM2HSDRV.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:				DATE OF ANALYSIS:				ANALYSIS METHOD:			
M2HS Bradley		Driver		X				Oct. 3, 1992				British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE	(mph)							RMS	RMQ	RMT
1	1	2.20	2.16	3.33	gravel	5	3.73	0.46	-0.40	0.12	0.15	0.25	0.89	0.43	0.36
3	1	2.07	2.14	3.33	gravel	15	3.32	0.48	-0.46	0.14	0.18	0.29	1.09	0.51	0.41
5	1	2.11	2.17	2.05	gravel	25	3.46	0.70	-0.64	0.19	0.26	0.41	1.50	0.71	0.57
8	3	3.07	2.63	2.55	gravel	35	4.32	1.81	-1.47	0.38	0.65	1.17	2.94	1.76	1.64
9	1	2.16	2.22	2.64	6" wshbrd	5	3.50	0.71	-0.68	0.20	0.27	0.43	1.54	0.74	0.60
11	4	2.63	2.27	2.72	6" wshbrd	15	4.58	1.26	-1.62	0.31	0.44	0.83	2.44	1.21	1.16
13	1	2.03	2.13	2.33	6" wshbrd	25	3.57	1.22	-1.25	0.35	0.45	0.70	2.68	1.24	0.98
14	1	2.43	2.26	3.07	sec-A	5	3.73	0.75	-0.49	0.17	0.23	0.40	1.29	0.63	0.57
16	1	2.11	2.23	3.29	sec-A	15	3.32	0.77	-0.94	0.26	0.34	0.54	2.00	0.96	0.77
19	3	2.77	2.90	2.58	sec-A	25	4.35	0.82	-0.87	0.19	0.32	0.54	1.51	0.88	0.76
20	3	2.43	2.39	2.77	XC #3	5	3.69	0.59	-0.79	0.19	0.26	0.45	1.45	0.74	0.64
22	3	2.27	2.51	3.23	XC #3	15	3.71	1.86	-1.90	0.51	0.72	1.15	3.93	1.99	1.62
23	3	2.46	2.53	3.11	XC #3	20	3.57	4.08	-2.43	0.91	1.31	2.25	7.06	3.62	3.16
24	2	2.41	2.18	4.19	paved	6	3.83	0.55	-0.44	0.13	0.17	0.31	1.00	0.48	0.44
26	2	1.89	2.02	5.02	paved	10	3.16	0.48	-0.63	0.18	0.22	0.33	1.36	0.61	0.47
28	2	1.97	2.14	6.70	paved	14	3.27	0.55	-0.62	0.18	0.23	0.35	1.39	0.65	0.50
30	1	2.08	2.20	3.50	paved	18	3.38	0.42	-0.51	0.14	0.18	0.29	1.07	0.50	0.40
32	1	2.19	2.16	3.69	paved	22	3.76	0.48	-0.55	0.14	0.18	0.30	1.06	0.50	0.42
34	1	2.08	2.22	2.48	paved	26	3.52	0.53	-0.50	0.15	0.20	0.31	1.14	0.54	0.43
36	1	2.16	2.16	3.96	paved	30	4.02	0.74	-0.75	0.19	0.24	0.40	1.43	0.67	0.56
38	1	2.35	2.23	3.25	paved	34	4.30	0.67	-0.73	0.16	0.22	0.38	1.26	0.61	0.54
40	1	2.21	2.21	3.85	paved	38	3.78	0.66	-0.70	0.18	0.24	0.40	1.39	0.67	0.56
42	2	2.07	2.22	4.05	CC #3	10	3.30	1.17	-1.20	0.36	0.48	0.74	2.78	1.33	1.04
44	4	4.51	2.20	3.05	CC #3	20	7.02	4.17	-2.53	0.48	0.80	2.15	3.70	2.24	3.03
SIGNAL TYPE					N % n										
1	mean	2.17	2.19	3.14	54.17	20.23	3.65	0.66	-0.66	0.18	0.24	0.39	1.41	0.67	0.55
	std. dev	0.11	0.04	0.60		10.95	0.28	0.21	0.23	0.06	0.08	0.12	0.47	0.22	0.17
2	mean	2.08	2.14	4.99	16.67	10.00	3.39	0.69	-0.72	0.21	0.28	0.43	1.63	0.77	0.61
	std. dev	0.23	0.08	1.22		3.27	0.30	0.32	0.33	0.10	0.14	0.21	0.79	0.38	0.29
3	mean	2.60	2.59	2.85	20.83	20.00	3.93	1.83	-1.49	0.44	0.65	1.11	3.38	1.80	1.56
	std. dev	0.32	0.19	0.31		11.18	0.38	1.38	0.69	0.30	0.42	0.72	2.31	1.16	1.01
4	mean	3.57	2.24	2.89	8.33	17.50	5.80	2.71	-2.08	0.40	0.62	1.49	3.07	1.72	2.10
	std. dev	1.33	0.05	0.23		3.54	1.73	2.05	0.65	0.11	0.26	0.94	0.89	0.73	1.32

YM2HSDRV.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:				DATE OF ANALYSIS:				ANALYSIS METHOD:			
M2HS Bradley		Driver		Y				Oct. 3, 1992				British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE	(mph)							RMS	RMQ	RMT
1	1	2.17	2.23	3.58	gravel	5	3.38	0.73	-0.66	0.21	0.28	0.45	1.60	0.77	0.63
3	2	1.93	2.13	4.25	gravel	15	3.06	0.66	-0.55	0.20	0.25	0.38	1.53	0.71	0.54
5	1	2.35	2.23	2.75	gravel	25	3.96	1.11	-1.30	0.31	0.42	0.72	2.36	1.16	1.01
8	3	2.31	2.31	2.62	gravel	35	3.44	1.07	-0.84	0.28	0.38	0.64	2.14	1.06	0.90
9	2	1.58	1.82	6.15	6" wshbrd	5	2.03	2.20	-1.85	1.00	1.21	1.59	7.75	3.37	2.23
11	2	1.59	1.85	6.38	6" wshbrd	15	2.19	2.28	-2.02	0.98	1.18	1.56	7.60	3.29	2.19
13	2	1.78	2.01	4.56	6" wshbrd	25	2.83	1.67	-1.65	0.59	0.73	1.05	4.55	2.04	1.47
14	2	2.11	2.14	4.80	sec-A	5	3.28	0.82	-0.69	0.23	0.30	0.48	1.78	0.84	0.68
16	4	2.80	2.28	3.36	sec-A	15	4.52	1.78	-1.60	0.37	0.55	1.05	2.90	1.54	1.47
19	3	3.03	2.79	2.79	sec-A	25	4.83	0.75	-0.84	0.16	0.28	0.50	1.28	0.77	0.70
20	3	2.19	2.36	3.53	XC #3	5	3.37	0.80	-0.75	0.23	0.32	0.50	1.78	0.88	0.71
22	4	2.86	2.30	5.25	XC #3	15	3.32	11.34	-4.98	2.46	3.77	7.04	19.05	10.50	9.90
23	4	2.50	2.21	5.92	XC #3	20	2.78	20.86	-8.77	5.33	7.94	13.33	41.26	22.01	18.75
24	3	2.31	2.35	3.91	paved	6	3.81	0.64	-0.66	0.17	0.24	0.39	1.32	0.66	0.56
26	4	2.71	2.48	5.13	paved	10	4.45	0.85	-0.87	0.19	0.29	0.52	1.50	0.80	0.74
28	4	2.70	2.30	2.76	paved	14	4.24	0.85	-0.64	0.18	0.25	0.47	1.36	0.70	0.67
30	4	3.11	2.22	3.54	paved	18	5.06	0.82	-0.78	0.16	0.25	0.49	1.23	0.68	0.69
32	4	2.70	2.37	2.97	paved	22	4.14	0.97	-0.74	0.21	0.30	0.56	1.60	0.84	0.79
34	4	3.61	2.26	2.90	paved	26	4.99	1.60	-0.88	0.25	0.40	0.90	1.93	1.12	1.26
36	4	2.81	2.49	3.92	paved	30	4.27	1.14	-0.89	0.24	0.36	0.67	1.84	1.00	0.94
38	4	2.54	2.46	2.95	paved	34	3.87	1.03	-0.92	0.25	0.37	0.64	1.95	1.02	0.90
40	3	3.10	2.65	3.85	paved	38	4.38	1.81	-1.00	0.32	0.50	0.99	2.48	1.39	1.40
42	4	4.23	2.33	4.47	CC #3	10	4.97	7.12	-3.21	1.04	2.00	4.40	8.06	5.57	6.19
44	3	3.99	2.66	5.58	CC #3	20	4.62	29.22	-9.07	4.15	7.63	16.55	32.13	21.21	23.27
SIGNAL TYPE					N % n										
1	mean	2.26	2.23	3.16	8.33	15.00	3.67	0.92	-0.98	0.26	0.35	0.58	1.98	0.96	0.82
	std. dev	0.12	0.00	0.59		14.14	0.41	0.27	0.45	0.07	0.10	0.19	0.54	0.27	0.27
2	mean	1.80	1.99	5.23	20.83	13.00	2.68	1.52	-1.35	0.60	0.74	1.01	4.64	2.05	1.42
	std. dev	0.23	0.15	0.97		8.37	0.55	0.76	0.68	0.39	0.46	0.57	3.01	1.28	0.80
3	mean	2.82	2.52	3.71	25.00	21.50	4.07	5.71	-2.19	0.89	1.56	3.26	6.86	4.33	4.59
	std. dev	0.69	0.20	1.06		14.01	0.62	11.52	3.37	1.60	2.98	6.51	12.39	8.28	9.16
4	mean	2.99	2.33	4.02	45.83	19.20	4.25	4.74	-2.35	1.05	1.62	2.95	8.11	4.50	4.15
	std. dev	0.52	0.10	1.11		7.89	0.71	6.43	2.56	1.60	2.40	4.10	12.39	6.66	5.77

ZM2HSDRV.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:				DATE OF ANALYSIS:				ANALYSIS METHOD:			
M2HS Bradley		Driver		Z				Oct. 3, 1992				British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
1	2	1.99	2.21	5.42	gravel	5	3.29	1.01	-1.09	0.32	0.42	0.63	2.47	1.16	0.89
3	2	1.82	2.05	5.69	gravel	15	2.98	1.92	-1.96	0.65	0.82	1.19	5.04	2.27	1.67
5	2	2.13	2.19	4.17	gravel	25	3.76	2.36	-2.44	0.64	0.84	1.36	4.94	2.34	1.91
8	1	2.11	2.20	3.71	gravel	35	3.71	2.75	-3.05	0.78	1.04	1.65	6.06	2.88	2.33
9	2	2.27	2.18	4.75	6" wshbrd	5	4.07	2.95	-2.93	0.72	0.97	1.65	5.60	2.69	2.31
11	2	2.03	2.15	4.44	6" wshbrd	15	3.39	5.93	-6.25	1.80	2.34	3.65	13.92	6.51	5.14
13	2	2.05	2.18	5.00	6" wshbrd	25	3.42	8.36	-8.33	2.44	3.20	4.99	18.89	8.90	7.02
14	2	1.80	2.07	5.14	sec-A	5	2.77	1.65	-1.71	0.61	0.77	1.09	4.69	2.13	1.54
16	2	1.88	2.05	7.47	sec-A	15	3.21	2.78	-2.63	0.84	1.06	1.59	6.52	2.95	2.23
19	3	3.33	2.99	4.86	sec-A	25	5.47	4.53	-5.17	0.89	1.57	2.96	6.87	4.37	4.16
20	2	2.16	2.16	6.42	XC #3	5	3.71	2.11	-2.13	0.57	0.75	1.23	4.43	2.09	1.73
22	4	3.99	2.13	4.74	XC #3	15	6.04	4.49	-9.97	1.20	1.72	4.78	9.27	4.79	6.72
23	4	5.99	2.15	2.91	XC #3	20	10.64	14.83	-18.60	1.57	3.32	9.40	12.16	9.25	13.22
24	2	2.37	2.18	6.32	paved	6	3.85	3.16	-3.78	0.90	1.23	2.14	6.99	3.43	3.01
26	2	1.47	1.78	10.76	paved	10	2.17	6.33	-6.41	2.93	3.42	4.32	22.71	9.53	6.08
28	2	1.84	2.02	9.49	paved	14	3.11	2.82	-2.74	0.90	1.12	1.65	6.94	3.12	2.32
30	2	2.14	2.21	5.40	paved	18	3.65	1.63	-1.56	0.44	0.58	0.94	3.39	1.62	1.32
32	2	2.23	2.19	4.67	paved	22	3.86	2.48	-2.27	0.62	0.82	1.37	4.77	2.28	1.93
34	1	2.07	2.16	3.92	paved	26	3.36	2.18	-2.16	0.65	0.85	1.34	5.01	2.36	1.89
36	1	2.14	2.18	3.74	paved	30	3.62	2.35	-1.70	0.56	0.73	1.20	4.33	2.04	1.68
38	1	2.50	2.21	3.14	paved	34	4.32	2.72	-2.32	0.58	0.79	1.46	4.52	2.21	2.05
40	2	2.24	2.21	4.53	paved	38	3.94	2.31	-2.43	0.60	0.81	1.35	4.66	2.25	1.90
42	2	2.06	2.18	7.65	CC #3	10	3.41	5.86	-5.66	1.69	2.22	3.47	13.09	6.18	4.88
44	4	6.95	1.84	2.73	CC #3	20	12.68	14.99	-14.69	1.17	3.02	8.13	9.07	8.40	11.44
SIGNAL TYPE					N % n										
1	mean	2.20	2.19	3.63	16.67	31.25	3.75	2.50	-2.31	0.64	0.85	1.41	4.98	2.37	1.99
	std. dev	0.20	0.02	0.34		4.11	0.41	0.28	0.56	0.10	0.13	0.19	0.77	0.36	0.27
2	mean	2.03	2.13	6.08	66.67	14.56	3.41	3.35	-3.39	1.04	1.34	2.04	8.07	3.72	2.87
	std. dev	0.23	0.11	1.89		9.37	0.49	2.09	2.10	0.76	0.93	1.31	5.89	2.59	1.85
3	mean	3.33	2.99	4.86	4.17	25.00	5.47	4.53	-5.17	0.89	1.57	2.96	6.87	4.37	4.16
	std. dev	n/a	n/a	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	5.64	2.04	3.46	12.50	18.33	9.79	11.44	-14.42	1.31	2.69	7.44	10.17	7.48	10.46
	std. dev	1.51	0.17	1.12		2.89	3.40	6.02	4.32	0.22	0.85	2.39	1.73	2.36	3.36

Appendix E

Seat Motion Data Summary for Cross-Country Operations

M1A1

XM1ACO_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Commander		X				Oct. 19/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				.		(mph)							RMS	RMQ	RMT
14	4	3.17	2.31	5.07	XC #3	6	10	4.04	3.87	-6.57	1.29	2.08	4.10	10.01	5.72	5.76
16	4	2.65	2.32	4.18	XC #3	6	20	3.89	5.46	-8.56	1.80	2.54	4.77	13.95	7.08	6.71
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
4	mean	2.91	2.31	4.62	2 (100)		15.00	3.97	4.66	-7.56	1.55	2.31	4.43	11.98	6.40	6.24
	std. dev	0.37	0.01	0.63			7.07	0.10	1.13	1.40	0.36	0.33	0.48	2.79	0.96	0.67

YM1ACO_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Commander		Y				Oct. 19/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE						(mph)							RMS	RMQ	RMT
14	4	3.64	2.49	4.65	XC #3	6	10	3.95	2.09	-6.16	1.04	1.87	3.80	8.08	5.08	5.34
16	3	2.43	2.49	3.98	XC #3	6	20	3.69	6.74	-5.57	1.67	2.42	4.05	12.93	6.73	5.70
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	2.43	2.49	3.98	1 (50)		20.00	3.69	6.74	-5.57	1.67	2.42	4.05	12.93	6.73	5.70
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	3.64	2.49	4.65	1 (50)		10.00	3.95	2.09	-6.16	1.04	1.87	3.80	8.08	5.08	5.34
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Commander		Z				Feb. 17/93					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
14	4	3.346	2.456	2.199	XC #3	6	10	6.053	6.566	-5.490	0.996	1.558	3.333	7.715	4.339	4.688
16	4	4.286	2.304	2.004	XC #3	6	20	7.679	30.321	-36.059	4.322	7.700	18.523	33.479	21.430	26.055
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
4	mean	3.82	2.38	2.10	2 (100)		15.00	6.87	18.44	-20.77	2.66	4.63	10.93	20.60	12.88	15.37
	std. dev	0.66	0.11	0.14			7.07	1.15	16.80	21.62	2.35	4.34	10.74	18.22	12.09	15.11

XM1ADR_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Driver		X				Oct. 19/92					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
14	4	4.62	2.48	4.47	XC #3	6	10	5.07	15.48	-5.55	2.08	4.50	9.60	16.08	12.30	13.50
16	4	4.60	2.32	4.18	XC #3	6	20	5.48	22.60	-7.06	2.71	4.92	12.44	20.97	13.70	17.50
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
4	mean	4.61	2.40	4.32	2 (100)		15.00	5.27	19.04	-6.30	2.39	4.71	11.02	18.53	13.00	15.50
	std. dev	0.02	0.11	0.21			7.07	0.29	5.03	1.07	0.45	0.30	2.01	3.46	0.99	2.83

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Driver		Y				Oct. 19/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE						(mph)							RMS	RMQ	RMT
14	4	4.53	2.56	5.42	XC #3	6	10	4.95	9.48	-3.33	1.30	2.76	5.87	10.03	7.56	8.25
16	3	2.35	2.39	3.11	XC #3	6	20	3.66	5.17	-3.90	1.24	1.72	2.92	9.61	4.79	4.10
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	2.35	2.39	3.11	1 (50)		20.00	3.66	5.17	-3.90	1.24	1.72	2.92	9.61	4.79	4.10
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	4.53	2.56	5.42	1 (50)		10.00	4.95	9.48	-3.33	1.30	2.76	5.87	10.03	7.56	8.25
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

ZM1ADR_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Driver		Z				Feb. 17/93					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE						(mph)							RMS	RMQ	RMT
14	3	3.995	2.636	2.338	XC #3	6	10	5.313	4.257	-1.871	0.577	1.019	2.304	4.467	2.814	3.240
16	4	8.472	2.088	2.206	XC #3	6	20	11.431	37.726	-15.926	2.347	6.649	19.883	18.178	18.507	27.967
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	3.99	2.64	2.34	1 (50)		10.00	5.31	4.26	-1.87	0.58	1.02	2.30	4.47	2.81	3.24
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	8.47	2.09	2.21	1 (50)		20.00	11.43	37.73	-15.93	2.35	6.65	19.88	18.18	18.51	27.97
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

XM1AGU_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Gunner		X				Oct. 19/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE						(mph)							RMS	RMQ	RMT
14	4	4.57	2.41	5.12	XC #3	6	10	4.96	13.89	-4.71	1.87	4.00	8.56	14.52	10.94	12.04
16	2	1.90	2.21	5.16	XC #3	6	20	2.82	13.29	-11.92	4.47	5.86	8.52	34.65	16.31	11.98
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	1.90	2.21	5.16	1 (50)		20.00	2.82	13.29	-11.92	4.47	5.86	8.52	34.65	16.31	11.98
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
4	mean	4.57	2.41	5.12	1 (50)		10.00	4.96	13.89	-4.71	1.87	4.00	8.56	14.52	10.94	12.04
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

YM1AGU_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Gunner		Y				Oct. 19/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE						(mph)							RMS	RMQ	RMT
14	4	2.95	2.38	3.80	XC #3	6	10	4.07	3.02	-2.02	0.62	0.94	1.82	4.80	2.62	2.57
16	4	3.03	2.12	4.58	XC #3	6	20	3.85	7.01	-3.38	1.35	1.98	4.09	10.45	5.54	5.75
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
4	mean	2.99	2.25	4.19	2 (100)		15.00	3.96	5.01	-2.70	0.98	1.46	2.96	7.62	4.08	4.16
	std. dev	0.06	0.18	0.55			7.07	0.16	2.82	0.97	0.52	0.73	1.60	4.00	2.07	2.25

ZM1AGU_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Gunner		Z				Feb. 17/93					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE						(mph)							RMS	RMQ	RMT
14	4	4.200	2.229	2.310	XC #3	6	10	5.980	7.496	-3.720	0.938	1.539	3.939	7.264	4.264	5.541
16	4	6.071	2.137	2.178	XC #3	6	20	9.517	37.510	-25.031	3.286	7.682	19.945	25.450	21.388	28.055
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
4	mean	5.14	2.18	2.24	2 (100)		15.00	7.75	22.50	-14.38	2.11	4.61	11.94	16.36	12.83	16.80
	std. dev	1.32	0.07	0.09			7.07	2.50	21.22	15.07	1.66	4.34	11.32	12.86	12.11	15.92

XM1ALO_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Loader		X				Oct. 19/92					British			
FILE ID	**SIGNAL**	**RMT/RMS**	**I(0.97)**	**SPECF**	**COURSE**	**#**	**SPEED**	**CF**	**MAX**	**MIN**	**RMS**	**RMQ**	**RMT**	**Dose (norm @ 60 sec)**		
(run #)	**TYPE**						**(mph)**							**RMS**	**RMQ**	**RMT**
14	4	2.99	2.58	4.60	XC #3	6	10	4.05	3.79	-2.34	0.76	1.22	2.27	5.86	3.36	3.19
16	3	2.36	2.36	3.30	XC #3	6	20	3.68	4.55	-4.08	1.17	1.65	2.76	9.07	4.61	3.88
SIGNAL TYPE					**N (%)**											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	2.36	2.36	3.30	1 (50)		20.00	3.68	4.55	-4.08	1.17	1.65	2.76	9.07	4.61	3.88
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	2.99	2.58	4.60	1 (50)		10.00	4.05	3.79	-2.34	0.76	1.22	2.27	5.86	3.36	3.19
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

YM1ALO_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Loader		Y				Oct. 19/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE						(mph)							RMS	RMQ	RMT
14	4	4.47	2.48	5.92	XC #3	6	10	4.98	12.27	-4.78	1.71	3.62	7.65	13.25	9.93	10.75
16	4	2.52	2.51	4.38	XC #3	6	20	3.97	7.49	-9.01	2.08	3.01	5.24	16.11	8.40	7.366
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
4	mean	3.49	2.49	5.15	2 (100)		15.00	4.47	9.88	-6.89	1.90	3.31	6.44	14.68	9.16	9.06
	std. dev	1.38	0.02	1.09			7.07	0.72	3.38	3.00	0.26	0.43	1.70	2.02	1.08	2.39

ZM1ALO_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1		Loader		Z				Feb. 17/93					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
14	4	3.054	2.471	2.035	XC #3	6	10	5.231	4.049	-4.918	0.857	1.328	2.618	6.639	3.695	3.682
16	4	5.866	2.105	1.776	XC #3	6	20	8.731	24.876	-16.595	2.375	5.166	13.930	18.396	14.371	19.595
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
4	mean	4.46	2.29	1.91	2 (100)		15.00	6.98	14.46	-10.76	1.62	3.25	8.27	12.52	9.03	11.64
	std. dev	1.99	0.26	0.18			7.07	2.48	14.73	8.26	1.07	2.71	8.00	8.31	7.55	11.25

M1A1 HTT

XM1HTD_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1 HIT		Driver		X				Oct. 14/92					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
24	2	2.47	2.29	5.01	XC #3	6	5	3.66	0.45	-0.38	0.11	0.16	0.28	0.87	0.45	0.39
25	4	4.12	2.45	5.26	XC #3	6	5	5.10	1.29	-0.66	0.19	0.37	0.79	1.48	1.02	1.11
26	4	3.21	2.59	4.47	XC #3	6	10	3.69	1.24	-0.55	0.24	0.40	0.78	1.88	1.12	1.10
27	4	5.51	2.22	5.96	XC #3	6	15	6.41	9.14	-3.62	1.00	2.32	5.48	7.71	6.42	7.71
28	3	3.11	3.00	5.63	XC #4	6	5	4.05	7.82	-4.88	1.57	2.67	4.87	12.14	7.43	6.85
29	4	6.40	1.23	5.03	XC #4	6	10	7.72	12.76	-5.92	1.21	3.32	7.75	9.37	9.24	10.89
30	2	2.08	2.17	4.37	Churchville B	6	5	3.14	0.25	-0.23	0.08	0.10	0.16	0.59	0.28	0.22
31	3	2.80	2.75	6.18	Churchville B	6	10	3.87	2.24	-1.81	0.52	0.83	1.46	4.04	2.30	2.05
36	3	4.04	3.07	8.54	Churchville B	6	15	5.13	7.56	-4.84	1.21	2.47	4.88	9.37	6.85	6.87
37	3	2.89	2.65	7.35	Churchville B	6	20	3.39	15.60	-7.31	3.38	5.36	9.78	26.17	14.91	13.75
38	3	2.74	2.85	8.93	Churchville B	6	25	3.62	10.23	-7.79	2.49	4.01	6.81	19.28	11.21	9.57
39	3	2.89	2.60	8.08	Churchville B	6	30	3.78	13.77	-8.52	2.95	4.57	8.51	22.82	12.69	11.96
40	4	3.57	2.35	8.43	Churchville B	6	35	4.42	20.60	-9.90	3.45	5.71	12.31	26.70	15.92	17.32
SIGNAL TYPE		(on Course #6)			N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	st. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	2.27	2.23	4.69	2 (15.38)		5.00	3.40	0.35	-0.30	0.09	0.13	0.22	0.73	0.36	0.31
	st. dev	0.28	0.08	0.45			0.00	0.36	0.14	0.10	0.03	0.04	0.08	0.20	0.11	0.12
3	mean	3.08	2.82	7.45	6 (46.15)		17.50	3.97	9.54	-5.86	2.02	3.32	6.05	15.64	9.23	8.51
	st. dev	0.49	0.19	1.32			9.35	0.61	4.80	2.50	1.10	1.65	2.98	8.51	4.58	4.19
4	mean	4.56	2.17	5.83	5 (38.46)		15.00	5.47	9.00	-4.13	1.22	2.42	5.42	9.43	6.74	7.63
	st. dev	1.35	0.54	1.55			11.73	1.61	8.19	3.92	1.33	2.23	4.90	10.26	6.22	6.89

YM1HTD_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1 HTT		Driver		Y				Oct. 14/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE						(mph)							RMS	RMQ	RMT
24	2	1.93	2.13	3.22	XC #3	6	5	3.01	0.28	-0.28	0.09	0.12	0.18	0.72	0.34	0.25
25	4	3.66	2.26	4.80	XC #3	6	5	4.39	0.58	-1.25	0.21	0.36	0.76	1.61	0.99	1.07
26	3	3.07	2.84	4.71	XC #3	6	10	3.67	0.89	-1.54	0.33	0.55	1.01	2.56	1.52	1.42
27	3	4.67	2.65	5.93	XC #3	6	15	5.88	4.48	-8.29	1.09	2.29	5.08	8.42	6.34	7.14
28	3	2.82	2.79	5.25	XC #4	6	5	3.49	3.97	-6.74	1.53	2.46	4.32	11.88	6.84	6.07
29	4	5.96	1.56	4.97	XC #4	6	10	6.84	4.66	-11.89	1.21	3.09	7.21	9.38	8.61	10.14
30	3	2.34	2.42	3.64	Churchville B	6	5	3.47	0.33	-0.29	0.09	0.13	0.21	0.69	0.35	0.29
31	3	2.27	2.59	7.12	Churchville B	6	10	3.27	1.62	-1.83	0.53	0.76	1.20	4.09	2.13	1.69
36	3	4.06	2.74	8.14	Churchville B	6	15	5.52	3.78	-5.19	0.81	1.65	3.30	6.30	4.59	4.64
37	4	2.51	2.54	7.23	Churchville B	6	20	3.47	7.07	-9.12	2.34	3.47	5.85	18.09	9.68	8.23
38	3	2.60	2.79	8.84	Churchville B	6	25	3.56	5.57	-6.89	1.75	2.76	4.54	13.56	7.72	6.39
39	4	2.79	2.58	7.90	Churchville B	6	30	3.62	5.83	-9.47	2.12	3.25	5.91	16.38	9.04	8.31
40	4	3.12	2.43	7.98	Churchville B	6	35	4.03	7.59	-13.18	2.58	4.06	8.04	19.94	11.33	11.31
SIGNAL TYPE		(on Course #6)			N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	st. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	1.93	2.13	3.22	1 (7.69)		5.00	3.01	0.28	-0.28	0.09	0.12	0.18	0.72	0.34	0.25
	st. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	mean	3.12	2.69	6.23	7 (53.85)		12.14	4.12	2.95	-4.39	0.88	1.51	2.81	6.78	4.21	3.95
	st. dev	0.91	0.15	1.88			6.99	1.09	1.99	3.14	0.62	1.04	1.97	4.78	2.90	2.77
4	mean	3.61	2.27	6.58	5 (38.46)		20.00	4.47	5.14	-8.98	1.69	2.85	5.55	13.08	7.93	7.81
	st. dev	1.38	0.42	1.57			12.75	1.37	2.79	4.64	0.98	1.44	2.83	7.55	4.02	3.98

ZM1HTD_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1A1 HTT		Driver		Z				Oct. 14/92					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
24	1	2.44	2.26	1.90	XC #3	6	5	4.14	0.42	-0.39	0.10	0.14	0.24	0.76	0.38	0.34
25	1	2.04	2.20	3.61	XC #3	6	5	3.43	0.60	-0.76	0.20	0.26	0.40	1.53	0.72	0.57
26	1	2.14	2.17	2.29	XC #3	6	10	3.68	0.54	-0.64	0.16	0.21	0.35	1.25	0.59	0.49
27	4	6.88	1.76	2.07	XC #3	6	15	12.12	3.80	-3.63	0.31	0.81	2.11	2.37	2.25	2.96
28	4	3.13	2.49	1.92	XC #4	6	5	5.19	1.52	-1.87	0.33	0.51	1.02	2.53	1.43	1.44
29	4	6.29	2.24	2.32	XC #4	6	10	10.54	1.95	-2.62	0.22	0.47	1.37	1.68	1.31	1.92
30	4	2.66	2.09	3.14	Churchville B	6	5	4.04	0.46	-0.79	0.15	0.21	0.41	1.20	0.58	0.58
31	1	2.34	2.19	2.12	Churchville B	6	10	3.85	0.44	-0.68	0.14	0.19	0.34	1.12	0.53	0.48
36	4	2.82	2.24	2.07	Churchville B	6	15	5.02	1.00	-1.09	0.21	0.30	0.59	1.62	0.84	0.83
37	4	10.83	1.56	2.09	Churchville B	6	20	17.88	22.33	-14.26	1.02	3.62	11.09	7.93	10.07	15.60
38	4	4.16	2.37	2.07	Churchville B	6	25	6.68	2.67	-2.08	0.36	0.65	1.48	2.75	1.81	2.08
39	4	4.63	2.19	2.35	Churchville B	6	30	7.73	3.54	-3.19	0.44	0.83	2.01	3.37	2.30	2.83
40	4	12.43	1.78	2.15	Churchville B	6	35	20.25	15.72	-8.75	0.60	2.02	7.51	4.68	5.63	10.56
SIGNAL TYPE		(on Course #6)			N (%)											
1	mean	2.24	2.21	2.48	4 (30.77)		7.50	3.78	0.50	-0.62	0.15	0.20	0.33	1.16	0.56	0.47
	st. dev	0.18	0.04	0.77			2.89	0.30	0.09	0.16	0.04	0.05	0.07	0.32	0.14	0.10
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	st. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	st. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
4	mean	5.98	2.08	2.24	(9) 69.23		17.78	9.94	5.89	-4.25	0.40	1.05	3.06	3.12	2.91	4.31
	st. dev	3.54	0.31	0.36			10.64	5.83	7.71	4.43	0.27	1.10	3.69	2.08	3.07	5.19

M1026 HMMWV

XHMVDR_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Driver		X				Oct. 16/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE						(mph)							RMS	RMQ	RMT
19	3	2.10	2.39	4.94	X-Country #3	6	5	3.24	0.61	-0.54	0.18	0.24	0.37	1.38	0.68	0.52
20	4	2.51	2.52	5.40	X-Country #3	6	10	3.71	1.17	-1.09	0.30	0.45	0.76	2.35	1.27	1.07
21	3	2.64	2.61	4.92	X-Country #3	6	15	3.80	1.86	-2.38	0.56	0.84	1.47	4.32	2.35	2.07
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	2.37	2.50	4.93	2 (66.67)		10.00	3.52	1.23	-1.46	0.37	0.54	0.92	2.85	1.51	1.30
	std. dev	0.38	0.16	0.01			7.07	0.40	0.88	1.30	0.27	0.42	0.78	2.08	1.18	1.10
4	mean	2.51	2.52	5.40	1 (33.33)		10.00	3.71	1.17	-1.09	0.30	0.45	0.76	2.35	1.27	1.07
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

YHMVDR_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Driver		Y				Oct. 16/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE						(mph)							RMS	RMQ	RMT
19	3	2.56	2.78	6.37	X-Country #3	6	5	3.92	0.87	-0.88	0.22	0.34	0.57	1.73	0.94	0.80
20	3	2.22	2.43	4.29	X-Country #3	6	10	3.27	1.05	-0.89	0.30	0.41	0.66	2.30	1.15	0.92
21	2	1.88	2.05	4.69	X-Country #3	6	15	2.83	1.51	-1.31	0.50	0.63	0.93	3.86	1.77	1.31
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	1.88	2.05	4.69	1 (33.33)		15.00	2.83	1.51	-1.31	0.50	0.63	0.93	3.86	1.77	1.31
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	mean	2.39	2.60	5.33	2 (66.67)		7.50	3.59	0.96	-0.89	0.26	0.38	0.61	2.01	1.04	0.86
	std. dev	0.24	0.25	1.47			3.54	0.46	0.13	0.00	0.05	0.05	0.06	0.40	0.15	0.08
4	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-

ZHMVDR_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Driver		Z				Oct. 16/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE						(mph)							RMS	RMQ	RMT
19	4	2.56	2.34	3.21	X-Country #3	6	5	3.91	1.38	-1.09	0.32	0.45	0.81	2.45	1.26	1.14
20	4	3.89	2.34	3.13	X-Country #3	6	10	5.43	3.55	-1.96	0.51	0.85	1.97	3.93	2.36	2.78
21	4	3.39	2.30	3.48	X-Country #3	6	15	4.90	5.70	-3.68	0.96	1.51	3.25	7.41	4.21	4.57
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
4	mean	3.28	2.33	3.27	3 (100)		10.00	4.75	3.54	-2.24	0.59	0.94	2.01	4.60	2.61	2.83
	std. dev	0.67	0.02	0.18			5.00	0.77	2.16	1.32	0.33	0.53	1.22	2.55	1.49	1.71

XHMVRR_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Road Rear		X				Oct. 16/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE						(mph)							RMS	RMQ	RMT
19	3	2.32	2.61	3.85	X-Country #3	6	5	3.30	0.32	-0.38	0.11	0.15	0.25	0.82	0.43	0.35
20	4	2.82	2.51	3.78	X-Country #3	6	10	4.31	0.80	-0.76	0.18	0.28	0.51	1.40	0.79	0.71
21	3	2.42	2.79	7.57	X-Country #3	6	15	3.12	0.93	-1.26	0.35	0.52	0.85	2.72	1.44	1.20
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	2.37	2.70	5.71	2 (66.67)		10.00	3.21	0.63	-0.82	0.23	0.34	0.55	1.77	0.94	0.77
	std. dev	0.07	0.13	2.63			7.07	0.13	0.43	0.63	0.17	0.26	0.43	1.35	0.71	0.60
4	mean	2.82	2.51	3.78	1 (33.33)		10.00	4.31	0.80	-0.76	0.18	0.28	0.51	1.40	0.79	0.71
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

YHMVRR_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Road Rear		Y				Oct. 16/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE						(mph)							RMS	RMQ	RMT
19	3	2.59	2.88	7.12	X-Country #3	6	5	3.55	0.76	-0.58	0.19	0.29	0.49	1.46	0.80	0.69
20	3	2.16	2.50	5.01	X-Country #3	6	10	3.14	0.67	-0.73	0.22	0.31	0.48	1.73	0.87	0.68
21	2	1.92	2.24	5.30	X-Country #3	6	15	2.57	0.91	-1.10	0.39	0.51	0.75	3.03	1.42	1.06
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	1.92	2.24	5.30	1 (33.33)		15.00	2.57	0.91	-1.10	0.39	0.51	0.75	3.03	1.42	1.06
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	mean	2.37	2.69	6.06	2 (66.67)		7.50	3.34	0.71	-0.66	0.21	0.30	0.48	1.60	0.83	0.68
	std. dev	0.30	0.27	1.49			3.54	0.29	0.06	0.11	0.03	0.02	0.00	0.19	0.05	0.00
4	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-

ZHMVRR_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Road Rear		Z				Oct. 16/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE						(mph)							RMS	RMQ	RMT
19	4	4.35	2.07	3.01	X-Country #3	6	5	5.55	3.06	-1.43	0.40	0.72	1.76	3.13	2.02	2.47
20	4	5.51	2.45	3.29	X-Country #3	6	10	6.58	7.19	-2.40	0.73	1.56	4.02	5.65	4.36	5.65
21	3	2.26	2.31	3.63	X-Country #3	6	15	3.37	3.34	-2.73	0.90	1.23	2.04	6.97	3.44	2.86
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	2.26	2.31	3.63	1 (33.33)		15.00	3.37	3.34	-2.73	0.90	1.23	2.04	6.97	3.44	2.86
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	4.93	2.26	3.15	2 (66.67)		7.50	6.07	5.12	-1.91	0.57	1.14	2.89	4.39	3.19	4.06
	std. dev	0.82	0.27	0.20			3.54	0.72	2.93	0.69	0.23	0.59	1.60	1.78	1.65	2.25

XHMVCR_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Curb Rear		X				Oct. 15/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE						(mph)							RMS	RMQ	RMT
19	3	2.36	2.30	3.45	X-Country #3	6	5	3.39	0.47	-0.32	0.12	0.16	0.27	0.90	0.45	0.39
20	1	2.17	2.27	3.86	X-Country #3	6	10	3.23	1.15	-1.15	0.36	0.49	0.77	2.76	1.36	1.09
21	3	2.69	2.74	5.34	X-Country #3	6	15	3.56	0.92	-1.32	0.31	0.48	0.85	2.44	1.33	1.19
SIGNAL TYPE					N (%)											
1	mean	2.17	2.27	3.86	1 (33.33)		10.00	3.23	1.15	-1.15	0.36	0.49	0.77	2.76	1.36	1.09
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	2.53	2.52	4.39	2 (66.67)		10.00	3.48	0.69	-0.82	0.22	0.32	0.56	1.67	0.89	0.79
	std. dev	0.24	0.31	1.34			7.07	0.12	0.32	0.71	0.14	0.23	0.41	1.09	0.63	0.57
4	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-

YHMVCR_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Curb Rear		Y				Oct. 15/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE						(mph)							RMS	RMQ	RMT
19	3	2.69	2.69	6.73	X-Country #3	6	5	3.73	0.98	-0.71	0.23	0.34	0.61	1.76	0.95	0.86
20	2	1.86	2.23	4.46	X-Country #3	6	10	2.65	0.92	-0.86	0.34	0.43	0.63	2.60	1.20	0.88
21	2	1.93	2.15	4.68	X-Country #3	6	15	2.55	1.21	-1.53	0.54	0.69	1.04	4.16	1.94	1.46
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	1.89	2.19	4.57	2 (66.67)		12.50	2.60	1.07	-1.20	0.44	0.56	0.83	3.38	1.57	1.17
	std. dev	0.05	0.05	0.15			3.54	0.07	0.20	0.47	0.14	0.18	0.29	1.10	0.52	0.41
3	mean	2.69	2.69	6.73	1 (33.33)		5.00	3.73	0.98	-0.71	0.23	0.34	0.61	1.76	0.95	0.86
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-

ZHMVCR_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Curb Rear		Z				Oct. 15/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE						(mph)							RMS	RMQ	RMT
19	4	2.55	2.33	3.36	X-Country #3	6	5	3.65	1.10	-0.66	0.24	0.34	0.61	1.87	0.93	0.86
20	4	4.08	2.45	2.69	X-Country #3	6	10	6.16	3.30	-2.30	0.45	0.81	1.85	3.52	2.27	2.61
21	3	2.34	2.36	3.29	X-Country #3	6	15	3.49	2.43	-2.03	0.64	0.89	1.49	4.95	2.49	2.10
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	2.34	2.36	3.29	1 (33.33)		15.00	3.49	2.43	-2.03	0.64	0.89	1.49	4.95	2.49	2.10
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	3.31	2.39	3.02	2 (66.67)		7.50	4.90	2.20	-1.48	0.35	0.58	1.23	2.69	1.60	1.73
	std. dev	1.08	0.09	0.48			3.54	1.78	1.55	1.16	0.15	0.34	0.88	1.17	0.94	1.23

XHMVCF_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Curb Front		X				Oct. 15/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE						(mph)							RMS	RMQ	RMT
19	3	2.10	2.33	3.23	X-Country #3	6	5	3.13	0.29	-0.30	0.09	0.13	0.20	0.73	0.36	0.28
20	4	2.63	2.43	3.33	X-Country #3	6	10	3.99	0.75	-0.61	0.17	0.25	0.45	1.32	0.70	0.63
21	3	2.23	2.44	5.19	X-Country #3	6	15	3.31	0.73	-0.85	0.24	0.33	0.53	1.85	0.93	0.75
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	2.16	2.39	4.21	2 (66.67)		10.00	3.22	0.51	-0.57	0.17	0.23	0.36	1.29	0.64	0.51
	std. dev	0.09	0.08	1.38			7.07	0.13	0.31	0.39	0.10	0.14	0.24	0.79	0.40	0.33
4	mean	2.63	2.43	3.33	1 (33.33)		10.00	3.99	0.75	-0.61	0.17	0.25	0.45	1.32	0.70	0.63
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

YHMVCF_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Curb Front		Y				Oct. 15/92					British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE						(mph)							RMS	RMQ	RMT
19	3	2.46	2.56	5.69	X-Country #3	6	5	3.81	0.63	-0.61	0.16	0.24	0.40	1.27	0.66	0.57
20	3	2.29	2.40	4.27	X-Country #3	6	10	3.27	0.84	-0.69	0.24	0.33	0.54	1.82	0.92	0.76
21	2	1.87	2.16	4.33	X-Country #3	6	15	2.73	1.02	-1.09	0.39	0.50	0.72	3.00	1.38	1.02
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	1.87	2.16	4.33	1 (33.33)		15.00	2.73	1.02	-1.09	0.39	0.50	0.72	3.00	1.38	1.02
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	mean	2.38	2.48	4.98	2 (66.67)		7.50	3.54	0.74	-0.65	0.20	0.29	0.47	1.55	0.79	0.66
	std. dev	0.12	0.12	1.00			3.54	0.38	0.15	0.06	0.05	0.07	0.10	0.39	0.19	0.14
4	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M1026_HMMWV		Curb Front		Z				Oct. 15/92					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	Dose (norm @ 60 sec) RMQ	Dose (norm @ 60 sec) RMT
·19	4	3.51	2.13	2.75	X-Country #3	6	5	4.92	2.16	-1.18	0.34	0.54	1.19	2.63	1.51	1.68
20	4	5.87	2.25	2.73	X-Country #3	6	10	8.29	5.70	-3.17	0.53	1.19	3.14	4.14	3.31	4.42
21	4	3.13	2.29	2.67	X-Country #3	6	15	5.07	3.13	-3.67	0.67	1.02	2.10	5.19	2.84	2.95
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
4	mean	4.17	2.23	2.72	3 (100)		10.00	6.09	3.66	-2.67	0.51	0.92	2.14	3.99	2.55	3.01
	std. dev	1.49	0.08	0.04			5.00	1.90	1.83	1.31	0.17	0.34	0.97	1.29	0.94	1.37

M109A3

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M109A3		Chief		X				Feb. 17/93					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE	#	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
29	1	2.105	2.289	3.915	XC #3	6	5	2.918	0.979	-0.729	0.293	0.397	0.616	2.268	1.105	0.867
30	3	2.992	2.766	6.640	XC #3	6	10	4.426	4.979	-4.271	1.045	1.727	3.126	8.094	4.806	4.398
SIGNAL TYPE					N (%)											
1	mean	2.11	2.29	3.92	1 (50)		5.00	2.92	0.98	-0.73	0.29	0.40	0.62	2.27	1.11	0.87
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	2.99	2.77	6.64	1 (50)		10.00	4.43	4.98	-4.27	1.05	1.73	3.13	8.09	4.81	4.40
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-

YM19CH_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M109A3		Chief		Y				Feb. 17/93					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE	#	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
29	3	2.085	2.305	3.670	XC #3	6	5	3.303	0.569	-0.596	0.176	0.237	0.368	1.365	0.660	0.517
30	3	2.785	2.706	4.920	XC #3	6	10	4.112	2.560	-2.935	0.668	1.061	1.861	5.175	2.955	2.617
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	2.44	2.51	4.30	2 (100)		7.50	3.71	1.56	-1.77	0.42	0.65	1.11	3.27	1.81	1.57
	std. dev	0.49	0.28	0.88			3.54	0.57	1.41	1.65	0.35	0.58	1.06	2.69	1.62	1.48
4	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-

VEHICLE		LOCATION		VIB. COMPONENT			DATE OF ANALYSIS					ANALYSIS METHOD			
M109A3		Chief		Z			Feb. 17/93					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
29	2	1.913	2.120	3.971	XC #3	5	3.103	4.189	-3.376	1.219	1.561	2.331	9.441	4.345	3.279
30	4	3.260	2.130	3.808	XC #3	10	4.777	14.840	-9.459	2.543	3.724	8.289	19.700	10.360	11.660
SIGNAL TYPE					N (%)										
1	mean	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-		-	-	-	-	-	-	-	-	-	-
2	mean	1.91	2.12	3.97	1 (50)	5.00	3.10	4.19	-3.38	1.22	1.56	2.33	9.44	4.35	3.28
	std. dev	n/a	n/a	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	mean	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-		-	-	-	-	-	-	-	-	-	-
4	mean	3.26	2.13	3.81	1 (50)	10.00	4.78	14.84	-9.46	2.54	3.72	8.29	19.70	10.36	11.66
	std. dev	n/a	n/a	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

XM19DR_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M109A3		Driver		X				Oct. 15/92					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE	#	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
														RMS	RMQ	RMT
29	2	1.96	2.16	3.09	XC #3	6	5	3.11	0.70	-0.79	0.24	0.31	0.47	1.85	0.87	0.66
30	4	2.74	2.37	3.69	XC #3	6	10	4.23	2.84	-2.62	0.65	0.99	1.77	5.01	2.76	2.49
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	1.96	2.16	3.09	1 (50)		5.00	3.11	0.70	-0.79	0.24	0.31	0.47	1.85	0.87	0.66
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
4	mean	2.74	2.37	3.69	1 (50)		10.00	4.23	2.84	-2.62	0.65	0.99	1.77	5.01	2.76	2.49
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

YM19DR_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M109A3		Driver		Y				Oct. 15/92					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE	#	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
														RMS	RMQ	RMT
29	1	2.32	2.19	2.86	XC #3	6	5	3.83	0.67	-0.62	0.17	0.23	0.39	1.30	0.63	0.55
30	4	2.66	2.53	4.62	XC #3	6	10	4.08	2.11	-2.47	0.56	0.84	1.49	4.34	2.34	2.10
SIGNAL TYPE					N (%)											
1	mean	2.32	2.19	2.86	1 (50)		5.00	3.83	0.67	-0.62	0.17	0.23	0.39	1.30	0.63	0.55
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
4	mean	2.66	2.53	4.62	1 (50)		10.00	4.08	2.11	-2.47	0.56	0.84	1.49	4.34	2.34	2.10
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

ZM19DR_X.XLS

VEHICLE		**LOCATION**		**VIB. COMPONENT**				**DATE OF ANALYSIS**					**ANALYSIS METHOD**			
M109A3		Driver		Z				Oct. 15/92					British			
FILE ID	**SIGNAL**	**RMT/RMS**	**I(0.97)**	**SPECF**	**COURSE**	**#**	**SPEED**	**CF**	**MAX**	**MIN**	**RMS**	**RMQ**	**RMT**	**Dose (norm @ 60 sec)**		
(run #)	**TYPE**				**TYPE**		**(mph)**							**RMS**	**RMQ**	**RMT**
29	2	1.99	2.17	2.46	XC #3	6	5	3.24	1.19	-1.25	0.38	0.49	0.75	2.91	1.36	1.06
30	4	4.13	2.25	2.43	XC #3	6	10	5.46	6.64	-3.13	0.89	1.55	3.70	6.93	4.30	5.20
SIGNAL TYPE					**N (%)**											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	1.99	2.17	2.46	1 (50)		5.00	3.24	1.19	-1.25	0.38	0.49	0.75	2.91	1.36	1.06
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
4	mean	4.13	2.25	2.43	1 (50)		10.00	5.46	6.64	-3.13	0.89	1.55	3.70	6.93	4.30	5.20
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M109A3		Gunner		X				Oct. 15/92					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE		SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
,29	2	1.94	2.23	3.43	XC #3	6	5	2.99	0.41	-0.46	0.15	0.19	0.28	1.13	0.53	0.40
30	3	2.78	2.74	4.96	XC #3	6	10	4.14	2.60	-2.95	0.67	1.07	1.87	5.19	2.98	2.62
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	1.94	2.23	3.43	1 (50)		5.00	2.99	0.41	-0.46	0.15	0.19	0.28	1.13	0.53	0.40
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	mean	2.78	2.74	4.96	1 (50)		10.00	4.14	2.60	-2.95	0.67	1.07	1.87	5.19	2.98	2.62
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-

YM19GU_X.XLS

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M109A3		Gunner		Y				Oct. 15/92					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE	#	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
29	2	1.99	2.17	3.38	XC #3	6	5	3.12	0.89	-0.77	0.27	0.35	0.53	2.07	0.97	0.75
30	3	2.84	2.87	6.09	XC #3	6	10	4.36	4.07	-4.24	0.95	1.55	2.71	7.38	4.31	3.81
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	1.99	2.17	3.38	1 (50)		5.00	3.12	0.89	-0.77	0.27	0.35	0.53	2.07	0.97	0.75
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	mean	2.84	2.87	6.09	1 (50)		10.00	4.36	4.07	-4.24	0.95	1.55	2.71	7.38	4.31	3.81
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-

VEHICLE		LOCATION		VIB. COMPONENT				DATE OF ANALYSIS					ANALYSIS METHOD			
M109A3		Gunner		Z				Oct. 15/92					British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE	#	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
														RMS	RMQ	RMT
29	2	1.69	1.96	6.33	XC #3	6	5	2.58	1.64	-1.66	0.64	0.78	1.08	4.95	2.18	1.52
30	4	4.36	2.00	3.31	XC #3	6	10	5.39	7.49	-3.40	1.01	1.85	4.40	7.83	5.15	6.20
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	1.69	1.96	6.33	1 (50)		5.00	2.58	1.64	-1.66	0.64	0.78	1.08	4.95	2.18	1.52
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
4	mean	4.36	2.00	3.31	1 (50)		10.00	5.39	7.49	-3.40	1.01	1.85	4.40	7.83	5.15	6.20
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

M923A2

X923UN_X.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:					DATE OF ANALYSIS:				ANALYSIS METHOD:			
XM923		Unknown		X					Oct 19, 1992				British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE		(mph)							RMS	RMQ	RMT
33	4	2.63	2.34	7.60	Perry #2	6	5	4.77	2.59	-3.04	0.59	0.84	1.55	4.57	2.34	2.18
35	4	3.33	2.46	9.30	Perry #2	6	15	5.04	14.65	-8.90	2.34	3.58	7.78	18.09	9.96	10.94
38	4	2.57	2.36	7.54	Perry #3	6	5	3.90	3.78	-2.69	0.83	1.18	2.13	6.42	3.28	3.00
40	2	1.89	2.07	7.78	Perry #3	6	15	2.97	15.80	-12.60	4.78	6.05	9.05	37.06	16.83	12.73
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	1.89	2.07	7.78	1 (25)		15.00	2.97	15.80	-12.60	4.78	6.05	9.05	37.06	16.83	12.73
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
4	mean	2.84	2.38	8.15	3 (75)		8.33	4.57	7.01	-4.88	1.25	1.87	3.82	9.69	5.19	5.37
	std. dev	0.42	0.07	1.00			5.77	0.60	6.65	3.49	0.95	1.49	3.44	7.33	4.15	4.84

Y923UN_X.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:					DATE OF ANALYSIS:				ANALYSIS METHOD:			
XM923		Unknown		Y					Oct. 19, 1992				British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE		(mph)							RMS	RMQ	RMT
33	4	4.10	2.28	4.68	Perry #2	6	5	6.25	0.81	-1.75	0.20	0.33	0.84	1.58	0.91	1.18
35	3	2.46	2.47	3.99	Perry #2	6	15	3.90	1.42	-1.60	0.39	0.56	0.95	3.00	1.56	1.34
38	2	2.07	2.22	5.46	Perry #3	6	5	3.29	1.01	-1.05	0.31	0.42	0.65	2.43	1.16	0.91
40	4	2.62	2.22	3.83	Perry #3	6	15	4.54	4.21	-4.05	0.91	1.28	2.38	7.04	3.57	3.34
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	2.07	2.22	5.46	1 (25)		5.00	3.29	1.01	-1.05	0.31	0.42	0.65	2.43	1.16	0.91
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	mean	2.46	2.47	3.99	1 (25)		15.00	3.90	1.42	-1.60	0.39	0.56	0.95	3.00	1.56	1.34
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	3.36	2.25	4.25	2 (50)		10.00	5.39	2.51	-2.90	0.56	0.80	1.61	4.31	2.24	2.26
	std. dev	1.05	0.04	0.60			7.07	1.20	2.40	1.63	0.50	0.68	1.09	3.86	1.88	1.53

VEHICLE:		LOCATION:		VIBRATION COMPONENT:					DATE OF ANALYSIS:				ANALYSIS METHOD:			
XM923		Unknown		Z					Oct. 19, 1992				British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE		(mph)							RMS	RMQ	RMT
33	4	20.93	1.86	2.38	Perry #2	6	5	27.47	2.70	-18.26	0.38	1.74	7.98	2.96	4.85	11.23
35	4	5.55	2.26	3.69	Perry #2	6	15	8.79	3.88	-9.25	0.75	1.20	4.15	5.78	3.35	5.83
38	1	2.18	2.21	2.84	Perry #3	6	5	3.74	1.54	-1.35	0.39	0.51	0.84	2.99	1.43	1.18
40	4	3.41	2.35	3.65	Perry #3	6	15	6.40	6.18	-5.56	0.92	1.43	3.12	7.10	3.98	4.39
SIGNAL TYPE					N (%)											
1	mean	2.18	2.21	2.84	1 (25)		5.00	3.74	1.54	-1.35	0.39	0.51	0.84	2.99	1.43	1.18
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
4	mean	9.96	2.16	3.24	3 (75)		11.67	14.22	4.25	-11.02	0.68	1.46	5.08	5.28	4.06	7.15
	std. dev	9.56	0.27	0.74			5.77	11.54	1.77	6.53	0.27	0.27	2.56	2.12	0.75	3.61

M2HS Bradley

XM2HCO_X.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:					DATE OF ANALYSIS:				ANALYSIS METHOD:			
M2HS Bradley		Commander		X					Oct. 15, 1992				British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE		(mph)							RMS	RMQ	RMT
20	3	2.86	2.80	3.72	XC #3	6	5	3.85	0.87	-0.64	0.20	0.32	0.56	1.52	0.88	0.79
22	2	1.98	2.34	8.04	XC #3	6	15	2.87	4.34	-4.20	1.49	1.99	2.94	11.50	5.55	4.14
23	2	2.09	2.29	7.99	XC #3	6	20	3.08	9.83	-7.99	2.90	3.91	6.07	22.45	10.89	8.53
42	4	2.72	2.47	4.82	CC #3	6	10	3.57	1.87	-1.16	0.42	0.63	1.15	3.28	1.75	1.62
44	3	3.16	2.66	5.95	CC #3	6	20	4.18	2.95	-6.00	1.07	1.77	3.38	8.29	4.91	4.75
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	2.04	2.31	8.02	2 (40)		17.50	2.97	7.08	-6.09	2.19	2.95	4.50	16.98	8.22	6.34
	std. dev	0.08	0.04	0.04			3.54	0.14	3.89	2.68	1.00	1.35	2.21	7.74	3.78	3.11
3	mean	3.01	2.73	4.84	2 (40)		12.50	4.01	1.91	-3.32	0.63	1.04	1.97	4.91	2.90	2.77
	std. dev	0.21	0.10	1.58			10.61	0.23	1.47	3.79	0.62	1.02	1.99	4.79	2.85	2.80
4	mean	2.72	2.47	4.82	1 (20)		10.00	3.57	1.87	-1.16	0.42	0.63	1.15	3.28	1.75	1.62
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

YM2HCO_X.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:					DATE OF ANALYSIS:				ANALYSIS METHOD:			
M2HS Bradley		Commander		Y					Oct. 15, 1992				British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE		(mph)							RMS	RMQ	RMT
.42	3	2.62	2.77	6.05	CC #3	6	10	3.77	2.11	-2.49	0.61	0.94	1.60	4.73	2.62	2.25
44	4	3.05	2.36	6.93	CC #3	6	20	4.19	3.18	-7.01	1.22	1.78	3.71	9.41	4.95	5.21
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	2.62	2.77	6.05	1 (50)		10	3.77	2.11	-2.49	0.61	0.94	1.60	4.73	2.62	2.25
	std. dev	n/a	n/a	n/a				n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	3.05	2.36	6.93	1 (50)		20	4.19	3.18	-7.01	1.22	1.78	3.71	9.41	4.95	5.21
	std. dev	n/a	n/a	n/a				n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

ZM2HCO_X.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:					DATE OF ANALYSIS:				ANALYSIS METHOD:			
M2HS Bradley		Commander		Z					Oct. 15, 1992				British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE		(mph)							RMS	RMQ	RMT
20	2	1.85	2.05	6.53	XC #3	6	5	2.96	1.28	-1.54	0.48	0.60	0.88	3.69	1.67	1.24
22	4	2.54	2.28	3.14	XC #3	6	15	4.20	4.12	-3.05	0.85	1.18	2.17	6.62	3.29	3.05
23	4	4.48	2.49	2.20	XC #3	6	20	7.83	20.28	-17.20	2.39	4.50	10.72	18.53	12.53	15.08
42'	2	2.27	2.15	4.06	CC #3	6	10	4.08	3.14	-3.45	0.81	1.07	1.83	6.26	2.97	2.58
44	4	6.80	1.99	1.83	CC #3	6	20	12.08	15.37	-11.29	1.10	2.54	7.50	8.55	7.06	10.55
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	2.06	2.10	5.29	2 (40)		7.50	3.52	2.21	-2.50	0.64	0.83	1.36	4.98	2.32	1.91
	std. dev	0.29	0.07	1.75			3.54	0.80	1.32	1.36	0.23	0.33	0.67	1.81	0.92	0.94
3	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
4	mean	4.61	2.25	2.39	3 (60)		18.33	8.04	13.26	-10.51	1.45	2.74	6.80	11.23	7.63	9.56
	std. dev	2.13	0.25	0.67			2.89	3.95	8.28	7.11	0.83	1.67	4.32	6.39	4.65	6.07

XM2HDR_X.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:					DATE OF ANALYSIS:				ANALYSIS METHOD:			
M2HS Bradley		Driver		X					Oct. 15, 1992				British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE		(mph)							RMS	RMQ	RMT
20	3	2.43	2.39	2.77	XC #3	6	5	3.69	0.59	-0.79	0.19	0.26	0.45	1.45	0.74	0.64
22	3	2.27	2.51	3.23	XC #3	6	15	3.71	1.86	-1.90	0.51	0.72	1.15	3.93	1.99	1.62
23	3	2.46	2.53	3.11	XC #3	6	20	3.57	4.08	-2.43	0.91	1.31	2.25	7.06	3.62	3.16
42	2	2.07	2.22	4.05	CC #3	6	10	3.30	1.17	-1.20	0.36	0.48	0.74	2.78	1.33	1.04
44	4	4.51	2.20	3.05	CC #3	6	20	7.02	4.17	-2.53	0.48	0.80	2.15	3.70	2.24	3.03
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	2.07	2.22	4.05	1 (20)		10.00	3.30	1.17	-1.20	0.36	0.48	0.74	2.78	1.33	1.04
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	mean	2.39	2.48	3.03	3 (60)		13.33	3.66	2.17	-1.71	0.54	0.76	1.28	4.14	2.12	1.81
	std. dev	0.10	0.07	0.24			7.64	0.07	1.77	0.84	0.36	0.52	0.90	2.81	1.45	1.27
4	mean	4.51	2.20	3.05	1 (20)		20.00	7.02	4.17	-2.53	0.48	0.80	2.15	3.70	2.24	3.03
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

YM2HDR_X.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:					DATE OF ANALYSIS:				ANALYSIS METHOD:			
M2HS Bradley		Driver		Y					Oct. 15, 1992				British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE		(mph)							RMS	RMQ	RMT
20	3	2.19	2.36	3.53	XC #3	6	5	3.37	0.80	-0.75	0.23	0.32	0.50	1.78	0.88	0.71
22	4	2.86	2.30	5.25	XC #3	6	15	3.32	11.34	-4.98	2.46	3.77	7.04	19.05	10.50	9.90
23	4	2.50	2.21	5.92	XC #3	6	20	2.78	20.86	-8.77	5.33	7.94	13.33	41.26	22.01	18.75
42	4	4.23	2.33	4.47	CC #3	6	10	4.97	7.12	-3.21	1.04	2.00	4.40	8.06	5.57	6.19
44	3	3.99	2.66	5.58	CC #3	6	20	4.62	29.22	-9.07	4.15	7.63	16.55	32.13	21.21	23.27
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	3.09	2.51	4.55	2 (40)		12.50	3.99	15.01	-4.91	2.19	3.97	8.53	16.96	11.04	11.99
	std. dev	1.27	0.22	1.45			10.61	0.88	20.10	5.88	2.77	5.17	11.35	21.46	14.38	15.95
4	mean	3.20	2.28	5.21	3 (60)		15.00	3.69	13.11	-5.66	2.94	4.57	8.26	22.79	12.69	11.61
	std. dev	0.91	0.06	0.73			5.00	1.14	7.04	2.84	2.18	3.05	4.59	16.91	8.43	6.45

ZM2HDR_X.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:					DATE OF ANALYSIS:				ANALYSIS METHOD:			
M2HS Bradley		Driver		Z					Oct. 15, 1992				British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE		(mph)							RMS	RMQ	RMT
20	2	2.16	2.16	6.42	XC #3	6	5	3.71	2.11	-2.13	0.57	0.75	1.23	4.43	2.09	1.73
22	4	3.99	2.13	4.74	XC #3	6	15	6.04	4.49	-9.97	1.20	1.72	4.78	9.27	4.79	6.72
23	4	5.99	2.15	2.91	XC #3	6	20	10.64	14.83	-18.60	1.57	3.32	9.40	12.16	9.25	13.22
42	2	2.06	2.18	7.65	CC #3	6	10	3.41	5.86	-5.66	1.69	2.22	3.47	13.09	6.18	4.88
44	4	6.95	1.84	2.73	CC #3	6	20	12.68	14.99	-14.69	1.17	3.02	8.13	9.07	8.40	11.44
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	2.11	2.17	7.04	2 (40)		7.50	3.56	3.98	-3.90	1.13	1.49	2.35	8.76	4.14	3.31
	std. dev	0.07	0.02	0.87			3.54	0.21	2.65	2.49	0.79	1.04	1.58	6.13	2.89	2.23
3	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
4	mean	5.64	2.04	3.46	3 (60)		18.33	9.79	11.44	-14.42	1.31	2.69	7.44	10.17	7.48	10.46
	std. dev	1.51	0.17	1.12			2.89	3.40	6.02	4.32	0.22	0.85	2.39	1.73	2.36	3.36

XM2HCR_X.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:					DATE OF ANALYSIS:				ANALYSIS METHOD:			
M2HS Bradley		Crew		X					Oct. 15, 1992				British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE	#	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec) RMS	RMQ	RMT
20	4	4.85	2.19	2.90	XC #3	6	5	5.93	0.61	-1.97	0.22	0.40	1.05	1.68	1.10	1.48
22					XC #3	6	15									
23	3	2.06	2.32	2.97	XC #3	6	20	3.41	3.18	-3.01	0.91	1.22	1.87	7.02	3.39	2.63
42	1	2.29	2.24	2.92	CC #3	6	10	3.48	1.39	-2.05	0.49	0.67	1.13	3.82	1.86	1.59
44	1	2.19	2.13	3.61	CC #3	6	20	3.31	2.12	-3.28	0.81	1.07	1.79	6.31	2.98	2.51
SIGNAL TYPE		(on Course #6)			N (%)											
1	mean	2.24	2.18	3.26	2 (50)		15.00	3.39	1.75	-2.66	0.65	0.87	1.46	5.07	2.42	2.05
	std. dev	0.07	0.08	0.49			7.07	0.12	0.52	0.87	0.23	0.28	0.46	1.76	0.79	0.65
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	2.06	2.32	2.97	1 (25)		20.00	3.41	3.18	-3.01	0.91	1.22	1.87	7.02	3.39	2.63
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	4.85	2.19	2.90	1 (25)		5.00	5.93	0.61	-1.97	0.22	0.40	1.05	1.68	1.10	1.48
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

YM2HCR_X.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:					DATE OF ANALYSIS:				ANALYSIS METHOD:			
M2HS Bradley		Crew		Y					Oct. 15, 1992				British			
FILE ID (run #)	SIGNAL TYPE	RMT/RMS	I(0.97)	SPECF	COURSE TYPE	#	SPEED (mph)	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
														RMS	RMQ	RMT
20	3	2.44	2.43	2.30	XC #3	6	5	3.16	0.44	-0.66	0.17	0.25	0.43	1.35	0.71	0.60
22					XC #3	6	15									
23	2	2.48	2.24	4.87	XC #3	6	20	3.15	3.09	-1.83	0.78	1.11	1.93	6.05	3.09	2.72
42	4	2.76	2.57	3.69	CC #3	6	10	4.30	2.01	-1.65	0.42	0.66	1.17	3.29	1.83	1.65
44	4	2.86	2.51	5.10	CC #3	6	20	3.98	3.85	-2.34	0.78	1.18	2.22	6.01	3.27	3.12
SIGNAL TYPE					N (%)											
1	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
2	mean	2.48	2.24	4.87	1 (25)		20.00	3.15	3.09	-1.83	0.78	1.11	1.93	6.05	3.09	2.72
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	mean	2.44	2.43	2.30	1 (25)		5.00	3.16	0.44	-0.66	0.17	0.25	0.43	1.35	0.71	0.60
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	mean	2.81	2.54	4.40	2 (50)		15.00	4.14	2.93	-1.99	0.60	0.92	1.70	4.65	2.55	2.39
	std. dev	0.07	0.05	0.99			7.07	0.22	1.30	0.49	0.25	0.37	0.74	1.93	1.02	1.04

ZM2HCR_X.XLS

VEHICLE:		LOCATION:		VIBRATION COMPONENT:					DATE OF ANALYSIS:				ANALYSIS METHOD:			
M2HS Bradley		Crew		Z					Oct. 15, 1992				British			
FILE ID	SIGNAL	RMT/RMS	I(0.97)	SPECF	COURSE	#	SPEED	CF	MAX	MIN	RMS	RMQ	RMT	Dose (norm @ 60 sec)		
(run #)	TYPE				TYPE		(mph)							RMS	RMQ	RMT
20	1	2.13	2.16	3.85	XC #3	6	5	3.55	1.39	-1.44	0.4	0.52	0.85	3.08	1.46	1.19
22					XC #3	6	15									
23	4	4.98	2.05	2.06	XC #3	6	20	8.35	19.45	-18.7	2.28	4.87	11.37	17.69	13.56	15.99
42					CC #3	6	10									
44					CC #3	6	20									
SIGNAL TYPE					N (%)											
1	mean	2.13	2.16	3.85	1 (50)		5.00	3.55	1.39	-1.44	0.40	0.52	0.85	3.08	1.46	1.19
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
3	mean	-	-	-	-		-	-	-	-	-	-	-	-	-	-
	std. dev	-	-	-			-	-	-	-	-	-	-	-	-	-
4	mean	4.98	2.05	2.06	1 (50)		20.00	8.35	19.45	-18.70	2.28	4.87	11.37	17.69	13.56	15.99
	std. dev	n/a	n/a	n/a			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Appendix F

Seat Motion Shock Data

VEHICLE:	M1A1								
Locations(s):	Commander								
	Gunner								
DIRECTION	**SHOCK**	**# OF**	**% OF TOTAL**	**PEAK AMP. RANGE**		**FREQ. RANGE (Hz)**		**No./min.**	
	TYPE	**SHOCKS**	**SHOCKS**	**+ ve**	**- ve**	**min.**	**max.**	**min.**	**max.**
Z	+1	10	52.63	5.0	-1.0	0.9	24.0		64
	+2	2	10.53	3.6	-1.5	2.3	2.6		
	+3	2	10.53	1.5	-1.3	1.6	15.0		
	+4	1	5.26	4.2	-1.5	1.6	1.6		
	-1	2	10.53	-2.1	-	2.1	8.5		
	-2	2	10.53	-2.3	1.8	1.2	1.3		
	-3		-	-	-	-	-	-	-
	-4		-	-	-	-	-	-	-
Total # shocks		19							
Y	+1		-	-	-	-	-	-	-
	+2		-	-	-	-	-	-	-
	+3		-	-	-	-	-	-	-
	+4		-	-	-	-	-	-	-
	-1		-	-	-	-	-	-	-
	-2		-	-	-	-	-	-	-
	-3	1	50	-4.0	2.7	56.0	56.0		2.66
	-4		-	-	-	-	-	-	-
	-9	1	50	0.8	1.5	26.0	26.0		
Total # shocks		2							
Total # of shocks with f <60 Hz:									

SHKM1A1.XLS

VEHICLE	LOCATION	RECORD #	DIRECTION	DURATION (s)	No. OF SHOCKS	Δ T Min (s)	Δ T Max (s)	SHOCK TYPE	PEAK AMPLITUDE + ve	PEAK AMPLITUDE - ve	FREQ. (Hz)
M1A1	Commander	16	Z (XC)	22.5	24	<.25	3.2	-2	-2.3	1.7	1.2
			"					-2	-2.1	1.8	1.3
			"					-1	-2.1	-	2.1
			"					-1	-1.5	-	8.5
			"					1	2.0	0.9	13.0
			"					1	1.8	-	8.5
			"					1	1.7	-	24.0
			"					3	1.5	-1.3	1.6
			"					1	1.5	-0.6	13.0
			"					1	1.7	-0.8	3.6
			"					3	1.4	-1.1	15.0
			"					1	1.5	-0.8	17.0
			"					2	1.3	-0.8	2.6
			"					1	4.1	-1.0	4.3
			"					2	3.6	-1.5	2.3
			"					4	4.2	-1.5	1.6
			"					1	1.0	-	8.5
			"					1	1.2	-0.8	0.9
			"					1	5.0	-1.0	6.4
			Y(XC)	22.5	16	0.4	6.7	-3	-4.0	2.7	56.0
	Gunner	22	Y	22.5	1	-	-	-9	0.8	1.5	26.0

FRQM109.XLS

VEHICLE:	M109								
Locations(s):	Driver								
	Gunner								
DIRECTION	**SHOCK**	**# OF**	**% OF TOTAL**	**PEAK AMP. RANGE**		**FREQ. RANGE (Hz)**		**No./min.**	
	TYPE	**SHOCKS**	**SHOCKS**	**+ ve**	**- ve**	**min.**	**max.**	**min.**	**max.**
Z	+1		-	-	-	-	-	-	-
	+2	2	50	1.2	-0.4	1.6	2.0	4	8.5
	+3		-	-	-	-	-	-	-
	+4	2	50	1.2	-0.7	1.7	1.9		
	-1		-	-	-	-	-	-	-
	-2		-	-	-	-	-	-	-
	-3		-	-	-	-	-	-	-
	-4		-	-	-	-	-	-	-
	-5		-	-	-	-	-	-	-
	-6		-	-	-	-	-	-	-
Total # shocks		4							
X	+1	1	100	1.0	-0.5	26.0	26.0	3	3
Total # shocks		1							
Total # of shocks with f <60 Hz:									

SHKM109.XLS

VEHICLE	LOCATION	RECORD #	DIRECTION	DURATION (s)	No. OF SHOCKS	Δ T Min (s)	Δ T Max (s)	SHOCK TYPE	PEAK AMPLITUDE + ve	PEAK AMPLITUDE - ve	FREQ. (Hz)
M109	Driver	030	Z	15.0	1	-	-	4	1.0	-0.3	1.9
		010	Z	21.0	3	1.3	2.1	2	1.2	-0.4	1.6
			Z					2	1.1	-0.2	2.0
			Z					4	1.2	-0.7	1.7
	Gunner	008	X	20.0	1	-	-	1	1.0	-0.5	26.0

VEHICLE:	M923								
Locations(s):	Unknown								
DIRECTION	SHOCK	# OF	% OF TOTAL	PEAK AMP. RANGE		FREQ. RANGE (Hz)		No./min.	
	TYPE	SHOCKS	SHOCKS	+ ve	- ve	min.	max.	min.	max.
Z	+1	-	-	-	-	-	-	-	-
	+2	1	100	1.7	-1.4	7.1	7.1		
	+3	-	-	-	-	-	-	-	-
	+4	-	-	-	-	-	-	-	-
	-1	-	-	-	-	-	-	-	-
	-2	-	-	-	-	-	-	-	-
	-3		-	-	-	-	-	-	-
	-4	-	-	-	-	-	-	-	-
Total # shocks		1							
Y	+1	-	-	-	-	-	-	-	-
	+2	-	-	-	-	-	-	-	-
	+3	-	-	-	-	-	-	-	-
	+4	-	-	-	-	-	-	-	-
	-1	-	-	-	-	-	-	-	-
	-2	-	-	-	-	-	-	-	-
	-3	1	100	-1.0	1.0	5.3	5.3		
	-4	-	-	-	-	-	-	-	-
Total # shocks		1							
Total # of shocks with f <60 Hz:									

SHKM923.XLS

VEHICLE	LOCATION	RECORD #	DIRECTION	DURATION (s)	No. OF SHOCKS	Δ T Min (s)	Δ T Max (s)	SHOCK TYPE	PEAK AMPLITUDE + ve	- ve	FREQ. (Hz)
M923	Unknown	27	Z	60.7	1	-	-	2	1.7	-1.4	7.1
			Y	60.7	1	-	-	-3	-1.0	1.0	5.3

VEHICLE:	M1076								
Locations(s):	Driver								
DIRECTION	**SHOCK TYPE**	**# OF SHOCKS**	**% OF TOTAL SHOCKS**	**PEAK AMP. RANGE + ve**	**- ve**	**FREQ. RANGE (Hz) min.**	**max.**	**No./min. min.**	**max.**
Z	+1		-	-	-	-	-	-	15
	+2		-	-	-	-	-	-	-
	+3		-	-	-	-	-	-	-
	+4		-	-	-	-	-	-	-
	-1		-	-	-	-	-	-	-
	-2	2	33.33	-2.3	1.0	3.0	3.0		
	-3	2	33.33	-1.1	-1.9	2.4	2.7		
	-4		-	-	-	-	-	-	-
	-5	1	16.67	-1.3	1.1	2.7	2.7		
	-6	1	16.67	-1.3	1.0	3.2	3.2		
Total # shocks		6							
Y	+1	1	100	1.2	-0.1	26	26		3
Total # shocks		1							
X	-1	6	75	-3.	0.7	3.2	9.0		24
	-2	2	25	-1.8	1.0	8.0	8.0		
Total # shocks		8							
Total # of shocks with f <60 Hz:									

SHKM1076.XLS

VEHICLE	LOCATION	RECORD #	DIRECTION	DURATION (s)	No. OF SHOCKS	Δ T Min (s)	Δ T Max (s)	SHOCK TYPE	PEAK AMPLITUDE + ve	PEAK AMPLITUDE - ve	FREQ. (Hz)
XM1076	Driver	015	Z	24.0	6	1.5	9	-3	-1.1	0.6	2.4
			Z					-5	-1.3	1.1	2.7
			Z					-3	0.7	-1.9	2.7
			Z					-2	-1.1	0.4	3.0
			Z					-6	-1.3	1.0	3.2
			Z					-2	-2.3	1.0	3.0
			X	20.0	8	0.28	15.3	-1	-1.3	0.1	6.4
			X					-1	-1.3	0.4	6.4
			X					-1	-1.3	0.2	6.4
			X					-1	-1.5	-	3.2
			X					-1	-3	0.4	9.0
			X					-1	-2.2	0.7	9.0
			X					-2	-1.8	1.0	8.0
			X					-2	-1.4	0.2	8.0
			Y	20	1	-	-	1	1.2	-0.1	26.0

VEHICLE:	M2HS									
Locations(s):	Commander									
	Driver									
DIRECTION	**SHOCK TYPE**	**# OF SHOCKS**	**% OF TOTAL SHOCKS**	**PEAK AMP. RANGE + ve**	**- ve**	**FREQ. RANGE (Hz) min.**	**max.**	**Freq. >=64 ?**	**No./min. min.**	**max.**
Z	+1	-	-	-	-	-	-	64		
	+2	-	-	-	-	-	-			
	+3	-	-	-	-	-	-			
	+4	-	-	-	-	-	-			
	+5	1	33.33	2.1	-1.7	32.0	32.0			
	-1	-	-	-	-	-	-			
	-2	-	-	-	-	-	-			
	-3	1	33.33	-2.5	1.8	51.0	51.0		-	-
	-4	1	33.33	-2.7	1.8	26.0	26.0		-	-
Total # shocks		3								
Y	+1	-	-	-	-	-	-	>64	-	-
	+2	-	-	-	-	-	-		-	-
	+3	1	50	5.7	-0.2	18	18		-	-
	+4	-	-	-	-	-	-		-	-
	-1	1	50	-1.2	0.5	-	-		-	-
	-2	-	-	-	-	-	-		-	-
	-3	-	-	-	-	-	-		-	-
	-4	-	-	-	-	-	-		-	-
Total # shocks		2								
X	+1	-	-	-	-	-	-	>64	-	-
	+2	-	-	-	-	-	-		-	-
	+3	-	-	-	-	-	-		-	-
	+4	1	50	1.5	-3.1	43	43		-	-
	-1	-	-	-	-	-	-	>64	-	-
	-2	-	-	-	-	-	-		-	-
	-3	1	50	-5.5	4.3	21	21		-	-
	-4	-	-	-	-	-	-		-	-
Total # shocks		2								
Total # of shocks with f < 60 Hz:										

SHKM2HS.XLS

1. MEDIAN SHOCKS

VEHICLE	LOCATION	RECORD #	DIRECTION	DURATION (s)	No. OF SHOCKS	Δ T Min (s)	Δ T Max (s)	SHOCK TYPE	PEAK AMPLITUDE + ve	- ve	FREQ. (Hz)
M2HS	Commander	044	Z	18.125	3	-	7.34	1	3.0	-1.3	64
			Z					5	2.1	-1.7	32
			Z					1	1.8	-0.6	64
		044	X	18.125	3		0.36	1	1.4	-	>64
			X					-1	-2.1	1.6	64
			X					4	1.5	-3.1	43
		023	Z	18.125	5	2.5	3.8	1	3.6	-0.7	5.3
		003	X	18.125	1	-	-	-1	-1.9	1.7	64
	Driver	044	Z	18.125	4	7.2	7.2	-3	-2.5	1.8	51
			Z					-4	-2.7	1.8	26
			X	18.125	3	7.2	7.2	-1	-3.8	2.0	>64
			X					-3	-5.5	4.3	21
			Y	18.125	3	-	7.2	1	3.6	-	>64
			Y					3	5.7	-0.2	18
		042	Y	18.125	1	-	-	-1	-1.2	0.5	-

TITLE:	1.0 TYPICAL SHOCKS						
DIRECTION:	X						
SHOCK	% OF TOTAL	PEAK AMP. RANGE (G)		FREQ. RANGE (Hz)		No./min.	
TYPE	SHOCKS	+ ve	- ve	min.	max.	min.	max.
+1	9	1.0	-0.5	26.0	26	3	24
+2							
+3							
+4	9	1.5	-3.1	43.0	43.0		
-1	55	-3.0	0.7	3.2	9.0		
-2	18	-1.8	1.0	8.0	8.0		
-3	9	-5.5	4.3	21.0	21.0		
-4							
Total # of shocks with f <60 Hz:		11					

TITLE:	1.0 TYPICAL SHOCKS						
DIRECTION:	Y						
SHOCK	% OF TOTAL	PEAK AMP. RANGE (G)		FREQ. RANGE (Hz)		No./min.	
TYPE	SHOCKS	+ ve	- ve	min.	max.	min.	max.
+1	20	1.2	-0.1	26.0	26.0	1.0	10.0
+2							
+3	20	5.7	-0.2	18.0	18.0		
+4							
-1	20	-1.2	0.5				
-2							
-3	20	-4.0	2.7	56.0	56.0		
-4							
-9	20	0.8	1.5	26.0	26.0		
Total # of shocks with f <60 Hz:		5					

TITLE:	1.0 TYPICAL SHOCKS						
DIRECTION:	Z						
SHOCK TYPE	% OF TOTAL SHOCKS	PEAK AMP. RANGE (G) + ve	- ve	FREQ. RANGE (Hz) min.	max.	No./min. min.	max.
+1	30	5.0	-1.0	0.9	24	3	27
+2	18	3.6	-1.5	1.60	7.1	1	5
+3	6	1.5	-1.3	1.6	15.0	3	5
+4	9	4.2	-1.5	1.6	1.9	3	4
+5	3	2.1	-1.7	32.0	32.0	3	3
-1	5	-2.1	-	2.1	8.5	3	5
-2	12	-2.3	1.8	1.2	3.0	3	5
-3	8	-2.5	1.9	2.1	51.0	3	5
-4	3	-2.7	1.8	26	26	3	3
-5	3	-1.3	1.1	2.7	2.7	3	3
-6	3	-1.6	1.0	3.2	3.2	3	3
				All shock types:		4	64
Total # of shocks with f <60 Hz:		33					

SHKM2HS3.XLS

2. SELECTED SHOCKS: XC			(cont'd)								
VEHICLE	LOCATION	RECORD #	DIRECTION	DURATION (s)	No. OF SHOCKS	Δ T Min (s)	Δ T Max (s)	SHOCK TYPE	PEAK AMPLITUDE + ve	- ve	FREQ. (Hz)
M2HS	Gunner	16	Z	22.5	7	1.05	4.57	-1	-1.0	1.5	1.05
		"	"					-1	-1.2	1.0	1.00
		"	"					2	1.5	-0.75	1.42
		"	"					1	4.0	-0.75	0.95
		"	"					1	3.7	-1.2	2.84
		"	"					2	4.5	-2.0	3.00
		"	"					3	2.6	-1.0	1.14
		"	"					2	6.5	-0.5	2.84
		"	Y	22.5	4	1.25	4.7	4	1.3	-0.5	12.8
		"	"					-4	-1.6	1.5	12.0
		"	"					3	2.5	-1.8	12.0
		"	"					-4	-3.0	1.5	25.6
	Loader	"	Z	22.5	7	1.05	3.52	-1	-2.0	0.7	0.95
		"	"					-2	-1.5	0.5	1.90
		"	"					-1	-1.5	0.7	1.42
		"	"					-4	-1.9	0.5	5.71
		"	"					2	2.0	-1.25	0.95
		"	"					2	4.0	-0.5	2.38
		"	"	22.5	12	0.7	2.812	3	3.0	-0.5	6.0
		"	"					3	3.0	-0.5	6.0
		"	"					3	3.2	-0.8	6.0
		"	"					2	3.5	-0.2	6.0
		"	"					-4	-0.8	3.0	6.0
		"	"					3	3.2	-0.6	6.0
		"	"					3	3.2	-0.7	6.0
		"	"					3	3.2	0.0	6.0
		"	"					-3	-1.4	3.8	6.0

SHKM2HS2.XLS

2. SELECTED SHOCKS: XC											
VEHICLE	LOCATION	RECORD #	DIRECTION	DURATION (s)	No. OF SHOCKS	Δ T Min (s)	Δ T Max (s)	SHOCK TYPE	PEAK AMPLITUDE + ve	- ve	FREQ. (Hz)
.M2HS	Commander	23	Z	18.5	9	0.5	2.5	-1	-1.2	1.5	1.0
		•	•					2	1.8	-0.8	2.1
		•	•					-1	-1.5	-0.8	1.1
		•	•					3	2.0	-1.3	1.6
		•	•				0.36	1	3.2	-1.0	1.8
	Driver	23	Z	18.5	12	0.25	3.8	4	2.6	-3.6	32.0
		•	•					-2	-1.5	2.0	21.0
		•	•					-2	-2.2	1.6	21.0
		•	•					-2	-1.7	1.4	21.0
		23	Y	18.5	9	0.94	3.75	1	1.0	-1.0	0.8
		•	•					3	3.0	-0.5	1.49
		•	•					1	1.75	-0.8	0.8
		•	•					3	1.75	-0.8	1.37
		•	•					2	3.0	-0.5	1.28
		•	•					1	1.5	-1.1	0.8
		•	•					3	1.75	-1.0	2.56
		•	•					2	4.0	-0.8	4.8
		•	•					1	2.7	-0.6	1.07
	LR_Crew	23	Z	18.5	7	1.25	4.063	-2	-1.6	1.0	2.13
		•	•					-1	-1.0	0.5	2.0
		•	•					2	1.7	-1.4	1.6
		•	•					3	1.2	-1.0	1.1
		•	•					-2	-1.5	1.0	1.6
		•	•					2	2.4	-1.1	1.28
		•	•					1	3.7	-1.7	0.8
		•	•					-3	-1.5	1.2	8.0
		•	•					3	1.2	-1.2	8.1
		•	•					-5	-1.6	1.0	42.0
		•	•					6	1.2	1.0	41.0
		44	Y	18.5	5	1.09	5	-3	-1.5	1.2	8.0
		•	•					3	1.2	-1.2	8.1
		•	•					-5	-1.6	1.0	42.0
		•	•					6	1.2	1.0	41.0
		•	•					1	1.5	-1.4	40.0

SHK_HT_A.XLS

2. SELECTED SHOCKS: XC			(cont'd)								
VEHICLE	LOCATION	RECORD #	DIRECTION	DURATION (s)	No. OF SHOCKS	Δ T Min (s)	Δ T Max (s)	SHOCK TYPE	PEAK AMPLITUDE + ve	- ve	FREQ. (Hz)
M1_HTT	Driver	40	X	21	2	2.5	-	+1	1.5	0.5	1.0
		.	.					+1	3.7	0.5	1.0
M1A1	Commander	16	X	22.5	8	1.0	3.0	+1	1.75	-1.20	60
		.	.					+1	2.25	-1.50	50
		.	.					+3	1.5	-2.00	40
		.	.					-4	1.5	-2.50	60
		.	.					+1	2.5	-1.75	26
		.	.					+4	4.0	-3.00	50
		.	.					-2	2.5	-5.00	60
		.	.					+1	1.5	-3.00	38

TITLE:	2.0 CROSS-COUNTRY SHOCKS						
DIRECTION:	X						
SHOCK	% OF TOTAL	PEAK AMP. RANGE (G)		FREQ. RANGE (Hz)		No./min.	
TYPE	SHOCKS	+ ve	- ve	min.	max.	min.	max.
+1	60	3.7	-3.0	1.0	60	20	60
+2							
+3							
+4	10	4.0	-3.0	-	50	20	60
-1							
-2	10	2.5	-5.0		60	20	60
-3	10	1.5	-2.0		40		
-4	10	1.5	-2.5		60	20	60
Total # of shocks with f <60 Hz:		10					

TITLE:	2.0 CROSS-COUNTRY SHOCKS						
DIRECTION:	Y						
SHOCK	% OF TOTAL	PEAK AMP. RANGE (G)		FREQ. RANGE (Hz)		No./min.	
TYPE	SHOCKS	+ ve	- ve	min.	max.	min.	max.
+1	27	2.7	-1.4	0.8	40.0	10.67	29.2
+2	11	4.0	-0.8	1.28	4.8		
+3	22	2.5	-1.8	1.4	12.0		
+4	5.5	1.3	-0.5	12.8	12.8		
-1	-	-	-	-	-		
-2	-	-	-	-	-		
-3	5.5	-1.5	1.2	8.0	8.0		
-4	11	-3.0	1.5	25.60	25.60		
Total # of shocks with f <60 Hz:		18					

TITLE:	2.0 CROSS-COUNTRY SHOCKS						
DIRECTION:	Z						
SHOCK	% OF TOTAL	PEAK AMP. RANGE (G)		FREQ. RANGE (Hz)		No./min.	
TYPE	SHOCKS	+ ve	- ve	min.	max.	min.	max.
+1	14	4.0	-1.7	0.8	2.8	3	5
+2	24	6.5	-2.0	0.95	6.0	3	8
+3	11	3.2	-1.2	1.1	8.1	3	3
+4	4	2.6	-3.6	32.0	32.0	3	3
-1	23	-2.0	1.5	0.5	2.0	3	6
-2	20	-2.2	2.0	1.6	21.0	3	9
-3							
-4	4	-1.9	3.0	5.71	5.71	3	3
				All shock types:		19	39
Total # of shocks with f <60 Hz:		30					

Appendix G

List of symbols and abbreviations

a	acceleration
a^{+}	positive acceleration amplitude exceeded for a fraction of time specified by $P(a^{+})$
a^{-}	negative acceleration amplitude exceeded for a fraction of time specified by $P(a^{-})$
$a(t)$	acceleration-time function
$a(u)$	acceleration time series
$a_1,..a_k$	acceleration amplitudes of waveform components at frequencies $f_1,..f_k$
a_{max}	maximum (peak) positive acceleration amplitude
a_{min}	maximum (peak) negative acceleration amplitude
$a_{(RM)}$	generalized time-averaged root mean acceleration
$a_{(RMS)}$	root mean square acceleration
$a_{(RMQ)}$	root mean quad acceleration
$a_W(t)$	frequency weighted acceleration time function
$a_{W(RMS)}$	frequency weighted, root mean square acceleration
$a_{W(RMQ)}$	frequency weighted, root mean quad acceleration
$a_{W(RMT)}$	frequency weighted, root mean twelfth acceleration
$a_{\Delta}(u)$	time series expressing spring compression in biodynamic model
$A(\omega)$	Fourier transform of $a(t)$
$A_{W(RMS)}(\omega_k)$	RMS acceleration in k^{th} 1/3 octave frequency band
$[A_{W(RMS)}(\omega_k)]_{max}$	maximum 1/3 octave frequency band RMS acceleration
ASCC	Air Standardization Coordinating Committee

α	recovery rate
b	intercept of discomfort contours
BCR	British Columbia Research Corporation
BS	British standard
c_j	j^{th} weight of dose function element
C	viscous resistance to motion, in biodynamic model
C_n	critical viscous damping, in biodynamic model
CREST	crest factor of waveform
$D(\ ,T)_{m,r}$	generalized dose function, moment m, root r
$D(a_W,T)_{2,2}$	"energy-equivalent" dose function for $a_W(t)$
$D(a_W,T)_{4,4}$	dose function called VDV
$D_N[\ ,T]_{m,r}$	time series dose function, moment m, root r, constructed from N dose elements
$D_{N_Q}[\ ,T]_{m,r}$	time series dose function, moment m, root r, for exposure to N_Q shocks
DOS	disk operating system for personal computers
DRI	dynamic response index
$(DRI_{max})_{n_q}$	maximum allowable DRI corresponding to the observed number of shocks, n_q
$(DRI)_q$	mean DRI value of q^{th} range of shocks
δ	decay rate of waveform
$\delta_1,..\delta_k$	decay rates of waveform components at frequencies $f_1,..f_k$
δ_k	k^{th} dose function element, moment m, root r, for a time series (abbreviated form)
$\delta_k[\ ,\Delta T]_{m,r}$	k^{th} dose function element, moment m, root r, for a time series
δ_N	most recent (current) time series dose function element, moment m, root r

δ_S	time series dose function element, moment m, root r, for exposure to one shock (abbreviated form)
δt	time separation of elements (samples) in a time series
Δ_{max}	maximum spring compression, in biodynamic model
ΔT	time interval
$E(a^2)$	second-order moment
$E(a^n)$	n^{th}-order moment
EMG	electromyography
f	frequency
$f_1, f_2, f_3, ..$	harmonically-related frequencies
FFT	fast Fourier transformation
FORTRAN	computer programming language (FORmula TRANsla-tion)
g	acceleration due to gravity (unit of accelera-tion)
GEDAP	GEneral Data Acquisition and Processing software system
$H(\omega)$	frequency weighting function
i	$\sqrt{-1}$
$I_{P(a)}$	impulsiveness defined for a probability value $P(a)$
I(0.97)	impulsiveness for probability value $P(a)=0.97$ (signal test parameter)
ISO	International Organization for Standardization
K	spring stiffness, in biodynamic model
$K_1 \quad K_2$	constants
KURT	kurtosis

m	moment of dose function, or expected value
m.p.h.	miles per hour
$m.s^{-2}$	meters per second, per second (unit of acceleration)
$m.s^{-1.75}$	meters per second to the power 1.75 (unit of VDV)
M	mass, in biodynamic model
MARS	multi-axis ride simulator
MIL	military
M1A1	tank
M109A3	self-propelled howitzer
M2HS	armored fighting vehicle
n	number of points per dose element
n_q	number of shocks observed in the q^{th} range of DRI values
N	number of dose elements in time series
N_q	maximum allowable number of shocks for the q^{th} range of DRI values
N_Q	total number of shocks
ω	angular frequency
$\omega_1, ..\omega_k$	angular frequencies of waveform components at frequencies $f_1, ..f_k$
ω_n	undamped natural (resonance) frequency of biodynamic model
$p(a)$	acceleration amplitude probability density distribution
$P(a)$	(cumulative) acceleration amplitude probability distribution
PDP	Digital Equipment Corporation mini-computer type (Peripheral Data Processor)
Q	number of ranges of DRI values
r	root of dose function

RMQ	root mean quad acceleration
RMS	root mean square acceleration
RMT	root mean twelfth acceleration
RMT/RMS	signal test parameter
s	slope of discomfort contours
SPECF	signal test parameter (SPECtral Factor)
STD	standard
σ	standard deviation of Gaussian random distribution
t	time
T	exposure time
T_Q	total exposure time to dose elements containing shocks
TGV	tactical ground vehicle
u	parameter identifying element of time series
$U(t)$	boxcar function (time function with "top-hat" profile)
USAARL	U.S. Army Aeromedical Laboratory
VAX	Digital Equipment Corporation mini-computer type
VDV	vibration dose value
VHS	tape-recording format (for Video Home System)
VMS	Digital Equipment Corporation mini-computer operating system (Virtual Memory System)
W_b	frequency weighting for the Z direction in BS 6841 (1987) (Z axis)
W_d	frequency weighting for the X and Y directions in BS 6841 (1987) (X and Y axes)
W.E.S.	Waterways Experimental Station
X	back-to-front (fore-and-aft) direction of motion
Y	right-to-left (side-to-side) direction of motion

Z	foot- or buttocks-to-head (vertical) direction of motion
ζ	damping ratio (fraction of critical damping), in biodynamic model